Level 1 and 2 Service Manual

Model A008 / A6188+ GSM Dual Band Technology

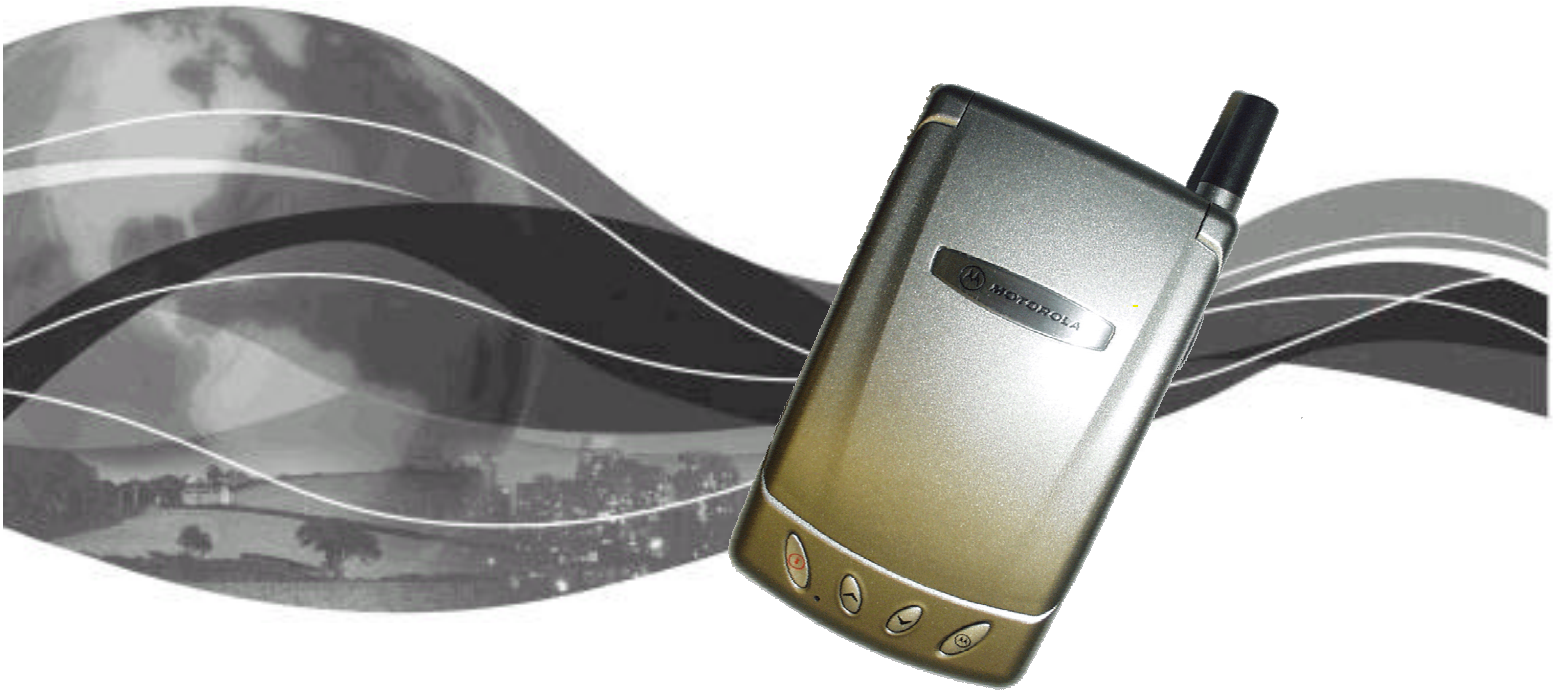

Table of Contents

Introduction V
Product Identification V
Product Names V
Product Changes V
Regulatory Agency Compliance V
Computer Software Copyrights VI
About This Service Manual VI
Warranty Service Policy VII
Specifications 1
Product Overview 2
Features 2
Controls and Indicators 8
User Interface Flowcharts 9
Tools and Test Equipment 14
Disassembly 14
Removing the Battery Door 14
Removing the Battery 15
Removing the housing screws 15
Separate front and rear housing 16
PCB Screw removal 16
Speaker connector removal 17
LCD & PCB removal 17
LCD & PCB Overview 18
LCD Flex removal 18
Subscriber Identity Module (SIM) Cards and Security 19
Inserting the SIM Card 19
Manual Test Mode 19
Personality Transfer 21
GSM Test Commands 21
Set up of User Profiles 22
Identity and Security 24
MSN 24
IMEI 24
Package Number 24
Picasso Labeling 25
Sales Model Numbers 26
Exploded View 27
Exploded View Parts List 28
Accessories 29

Introduction

Motorola® Inc. maintains a worldwide organisation that is dedicated to provide responsive, full-service customer support. An international network of company-operated product care centres as well as authorised independent service firms service Motorola products.

Available on a contract basis, Motorola Inc. offers comprehensive maintenance and installation programs which enable customers to meet requirements for reliable, continuous communications.

Product Identification

The model number on the housing identifies Motorola products. Use the entire model number when inquiring about the product. Numbers are also assigned to chassis and kits. Use these numbers when requesting information or ordering replacement parts.

Product Names

Product names included in this manual are listed on the front cover. Product names are subject to change without notice. Some product names, as well as some frequency bands, are available only in certain markets.

Product Changes

When electrical, mechanical or production changes are incorporated into Motorola products, a revision letter is assigned to the chassis or kit affected, for example; -A, -B, or -C, and so on.

The chassis or kit number, complete with revision number is imprinted during production. The revision letter is an integral part of the chassis or kit number and is also listed on schematic diagrams and printed circuit board layouts.

Regulatory Agency Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

This device may not cause any harmful interference, and

This device must accept interference received, including interference that may cause undesired operation.

This class B device also complies with all requirements of the Canadian Interference-Causing Equipment Regulations (ICES-003).

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Computer Software Copyrights

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About This Service Manual

Using this service manual and the many suggestions contained in it assures proper installation, operation, and maintenance of the A008. Refer any questions about this manual to the nearest Customer Service Manager.

Audience

This document provides assistance to service personnel in testing and repairing the A008. Service personnel should be familiar with electronic assembly, testing, and troubleshooting methods, and with the operation and use of associated test equipment.

Use of this document assures proper installation, operation, and maintenance of Motorola products and equipment. It contains all service information required for the equipment described and is current as of the printing date.

Scope

The scope of this document is to provide the reader with basic information relating to the A008, and also to provide procedures and processes for repairing the units at Level 1 and 2 service centres including:

Unit swap out

Repairing of mechanical faults

Basic modular troubleshooting

Testing and verification of unit functionality

Initiate warranty claims and send any faulty modules to Level 3 or 4 repair centres.

Finding Information

The first three digits of the serial number identify a product family, unless covered by an extended warranty. Extended warranty products have two alphabetic characters in place of the first two digits of the family code. The

first digit following the alphabetic code indicates the number of years the warranty period is in effect.

This Service Manual consists of the following sections:

Overview - Describes the features, specifications, and options.

Operation - Provides a theory of operation, describes message handling, and how to program the communicator, and a functional overview.

Disassembly - Procedures for removing and replacing assemblies and a troubleshooting chart.

Part Numbers - Provides diagrams and associated parts lists.

Conventions

Special characters and typefaces, listed and described below, are used in this publication to emphasise certain types of information.

	Note: Emphasises additional information pertinent to the subject manner
	Caution: Emphasises information about actions that may result in equipment damage.
	Warning: Emphasises information about actions that may result in personal injury.
Enter	Keys to be pressed are represented graphically. For example, instead of “Press the Enter Key”, you will see “Press
	Information from a screen is shown in text as similar as possible to what appears in the display. For example
Bold	Information that you need to type is printed in **boldface type**.

Revisions

Any changes that occur after manuals are printed are described in publication revision bulletins (*PMRs*). These bulletins provide change information that can include new parts listing data, schematic diagrams, and printed board layouts.

Warranty Service Policy

The product will be sold with the standard 12 months warranty terms and conditions. Accidental damage, misuse, and extended warranties offered by retailers are not supported under warranty. Non warranty repairs are available at agreed fixed repair prices.

Out of Box Failure Policy

The standard out of box failure criteria applies. Customer units that fail very early on after the date of sale are to be returned to Manufacturing for root cause analysis, to guard against epidemic criteria. Manufacturing to bear the costs of early life failure.

Product Support

Customer's original units will be repaired but not refurbished as standard. Appointed Motorola Service Hubs will perform warranty and non-warranty field service for level 2 (assemblies) and level 3 (limited PCB component). The Motorola HTC centres will perform level 4 (full component) repairs.

Customer Support

Customer support is available through dedicated Call Centres and in-country help desks. Product Service training should be arranged through the local Motorola Support Centre.

Ordering Replacement Parts

Only centres authorised to carry out repairs can purchase spare parts. Orders for spare parts from hubs and Hi-Tech Centres should be placed with the regional Motorola Parts Distribution Centre.

Specifications

General Function	**Specification**
Frequency Range GSM Frequency Range DCS Frequency Range PCS	880-915 MHz TX (with EGSM) 925-960 MHz RX 1710-1785 MHz TX 1805-1880 MHz Rx 1850.2 – 1909.8 MHz TX 1930.2 – 1989.8 MHz Rx
Channel Spacing	200 kHz
Channels	174 GSM/374 DCS carriers with 8 channels per carrier
Modulation	GMSK at BT = 0.3
Transmitter Phase Accuracy	5 Degrees RMS, 20 Degrees peak
Duplex Spacing	45 MHz GSM 95MHz DCS 80MHz PCS
Frequency Stability	± 0.10 PPM of the Downlink frequency (Rx)
Operating Voltage	Full Rate PSU = 4.4V +/- 5% (During Charging = VBatt +/-5% 6.63V Mid Rate Charger = 5.9V +/- 0.3V CLA Supply = 4.4V Battery Operating Voltage = 2.85V(Radio Shut Down voltage) To 4.2V Max
Transmit Current	Typically 250 ma avg., 1.0A peak
Stand-by Current	Typically 7.0 ma (DRX2)
Dimensions	130mm x 46mm x 24.5mm
Size (Volume)	105cc with Batt
Weight	106g with Batt
Temperature Range	-10C to +55C

Transmitter

Function	***Specification***
RF Power Output	33 dBm ± 2dB GSM/ 30 dBm ± 2 dB DCS
Output Impedance	50 ohms (nominal)
Spurious Emissions	-36 dBm from 0.1 to 1 Ghz -30 dBm from 1 to 4 Ghz

Receiver

Function	***Specification***
RF Level	-102 dBm
RX bit error rate (100 k bits)	< 2%
Channel Hop Time	500 microseconds
Time to Camp	Approximately 5-10 seconds

Speech Coding

Function	***Specification***
Speech Coding Type	Regular Pulse Excitation / Linear Predictive Coding with Long Term Prediction. (RPE LPC with LTP).
Bit Rate	13.0 k bps
Frame Duration	20 ms
Block Length	260 bits
Classes	Class 1 bits = 182 bits. Class 2 bits = 78 bits
Bit Rate with FEC Encoding	22.8 k bps

Product Overview

Features

The A008 (E MEA) A6188+ (Asia) is a GSM dual band (900/1800 MHz) GPRS product, and is an enhanced version of A6188. From this point onwards we will refer to this product as the A008. The A008 is mechanically very similar to the existing A6188 form factor with slight modifications made to the flip and front Housing to ensure a different look.
The display will be 320 x 240 pixels, 4 level gray scale ¼ VGA display. The display shall be 24 x 24 bitmap for Chinese Characters and 15 x 16 bitmap for English Characters. The line spacing has been modified for easier reading.

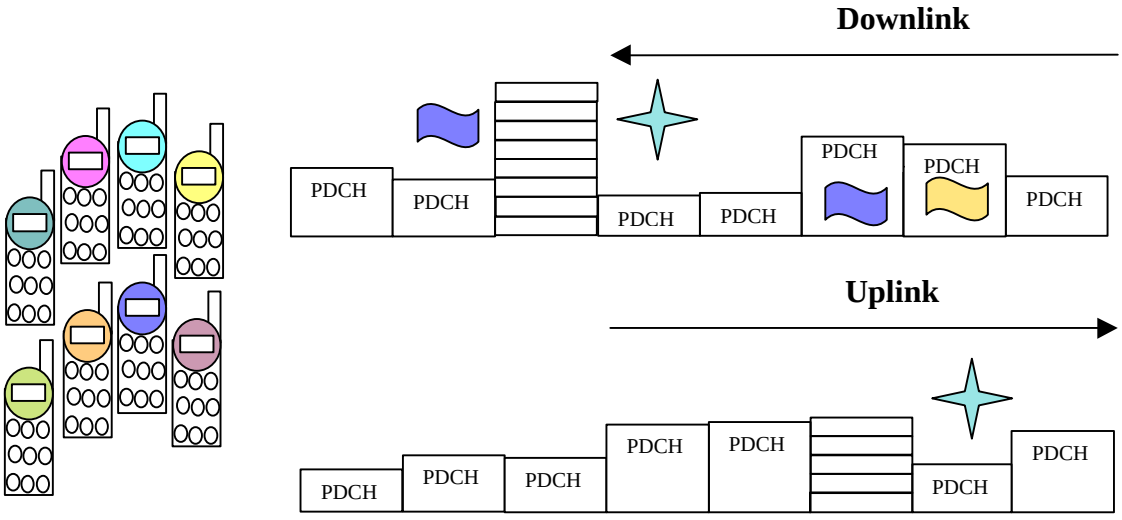
There will be 2 new Colours, Mica Grey, Summer Sky Blue/TT silver

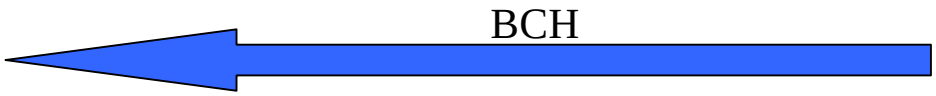
In additional to the existing A6188 User Interface features the following features / applications will be available

GPRS – General Packet Radio service

GPRS (General Packet Radio Service) is a combination of HSCSD (High Speed Circuit Switched Data) and SMS (Short Message Service). It has a theoretical speed of 171.2kbps compared with 9.6kbps as today. A single user using all 8 uplink timeslots and all 8 Downlink timeslots could theoretically achieve this. The main purpose for GPRS is to give 'immediacy' to the customer i.e. to allow the customer access to data transfer as and when they need it.
Information will be carried across as IP from Internet sites etc…

For GPRS the Traffic Channel (TCH) now becomes the Packet Data Channel (PDCH)





As can be seen from the above drawing, up to 8 different users can occupy 1 single timeslot at any given time. The more Bandwidth that is required, the more channels are allocated by the network.

This extra timeslot allocation is only given when the network is not busy, and therefore dynamically maximises idle network resources. Also because much of the SMS messaging will now be carried over the GPRS system this will relive much of the SMS Centre loading.

Also the Uplink and Downlink are now completely separate channels in that we can now have an uplink only and downlink only channel allocated by the network.

GPRS is high bandwidth data split at source into separate but related data 'packets'. The information packets that a GPRS enabled phone is to receive, is addressed specifically for that phone using a TFI - Temporary Flag Indicator.

And although the phone will 'listen' to each timeslot of data but will only decode the information that is highlighted by a matching TFI.

By setting a USF – Uplink Status Flag on a Downlink timeslot, the mobile phone is instructed it can transmit on the next available uplink timeslot.

GPRS will support GSM 900 / 1800 / 1900 as well as TDMA technologies

For GPRS to operate the following must be available:

- Mobile phone must be of GPRS technology
- Network provider must support GPRS which includes a modified Infrastructure (Core Network)

GPRS can be set up manually through the UI or using the PC Tools programming equipment. The A008 will be a 1 up 2 down GPRS technology i.e. it supports 2 timeslots of Downlink information per Frame and 1 uplink slot.

E – Mail

- 5 mailboxes
- POP3, IMAP4, SMTP, MIME
- Text, Inkpad, V-Card attachment

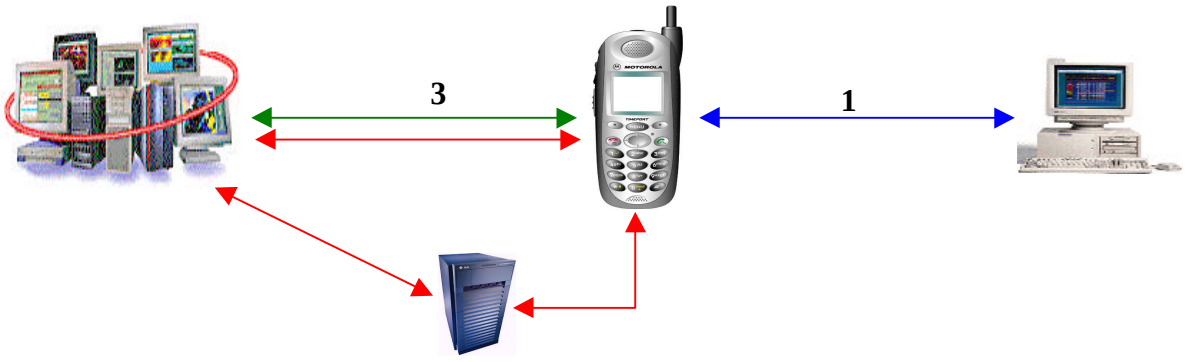
K-Java

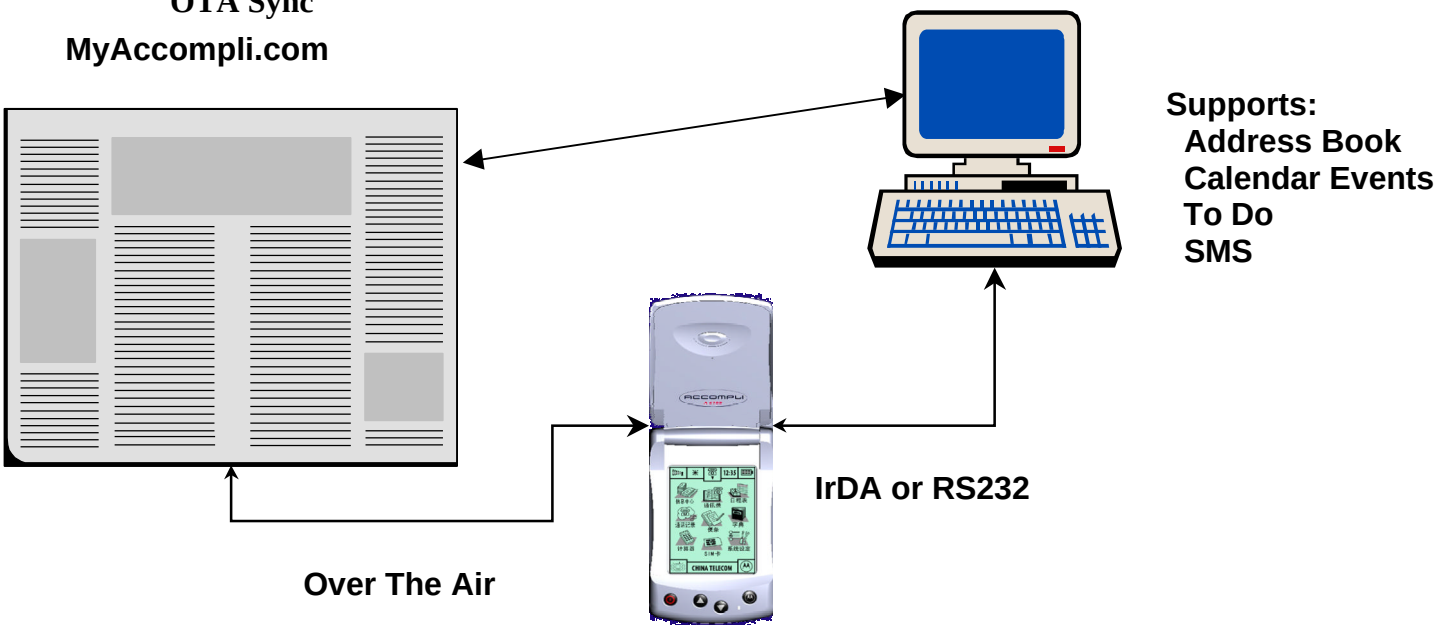
K-Java is basically a protocol used to download applications to a device; there are 3 methods of achieving this.

1) Web to PC Synchronisation –
- Download application package to PC using standard Internet protocols
- Installation from PC to devices through cable or local wireless

2) WAP / HTTP -
- Browse applications using WAP browser
- Download application package using http protocol

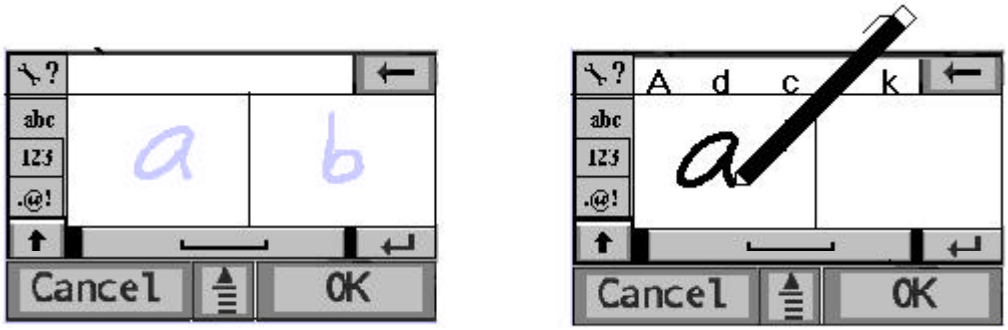
3) HTTP (end to End) -
- Browse applications with special-purpose Java service browser using http
- Download application package using http protocol





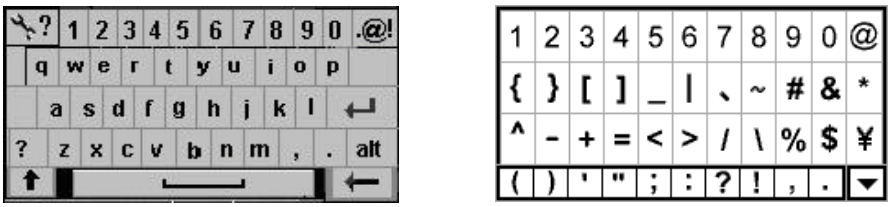
- SyncML based OTA TrueSync
- Enables A008 users to synchronize data to the Internet
- Enables associates to update your schedule over the air

Improved Hand writing recognition



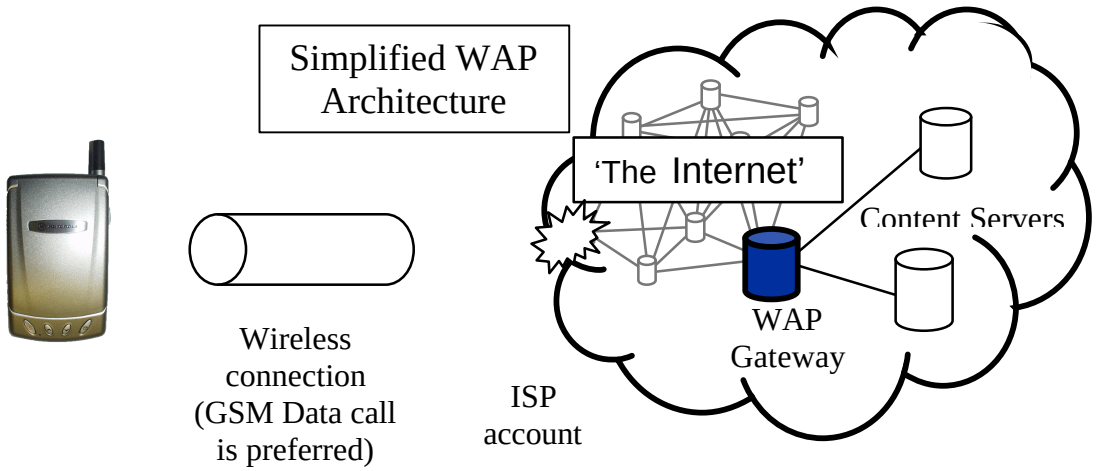
Compared to the original A6188. There are now 2 handwriting screens allowing successive letters to be entered whilst the system processes the previous action.

- European HWR based from Lexicus
- Initially supports Phase 1 EMEA languages
- Virtual Keypads available.



Virtual Keypad Symbol Keypad

WAP 1.1 (Wireless Application Protocol)



WAP Format is derived as follows

1. The request for information is made in WML (Wireless Mark-Up Language) derived from HTML.
2. Request is passed to WAP Gateway, which retrieves the information from the server in standard HTML (which is then filtered to WML) or if available WML format.
3. The information is then passed the cellular user, via the cellular network provider.

All settable parameters can be entered manually or programmed using *PC Tools*

For image download, the bitmap image will be downloaded as text and if the image is larger than the screen then only part of the image will be displayed

During browser mode, if incoming call is received then the browser will be paused with the user having the option to resume after the call.

Other Options covered within the Menu Chapter are:

- Address Book
- Recent calls
- Call Divert
- STK Option
- E-Mail
- Messages
- Turbo Dial
- Integration
- Instant messaging

Communicate Menu Option

- Text Notes
- Ink Notes
- Voice Notes
- Melody Composer
- To Do List
- Date Book

Annotate Menu Option

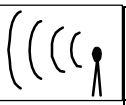
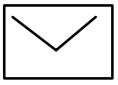
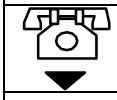
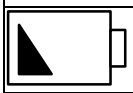
- Calculator
- Conversion Calculator
- Currency Calculator
- World Time

Extras Menu Option

- Alarm Clock
- Dictionary
- Truesync
- Games
- Receive IR
- Soft Modem

Tools Menu Option

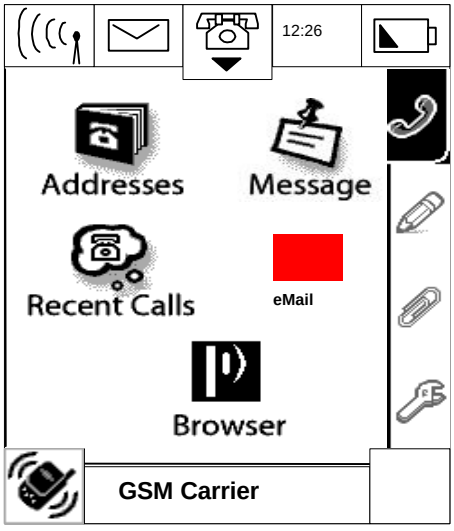
Controls and Indicators

	Shows user current signal strength
	Takes user to messages structure
	When Pressed brings up phone Keypad menu
12:20	Present Time
	Shows user present battery meter reading 1/3 – 2/3 or Full
b	STK access & User Information
	Takes user to Call Divert Sub Menu
	Informs user they are within ‘Communicate’ Menu
	When pressed brings up ‘Annotate’ Menu
	When pressed brings up ‘Extras’ Menu
	When pressed brings up ‘Tools’ Menu

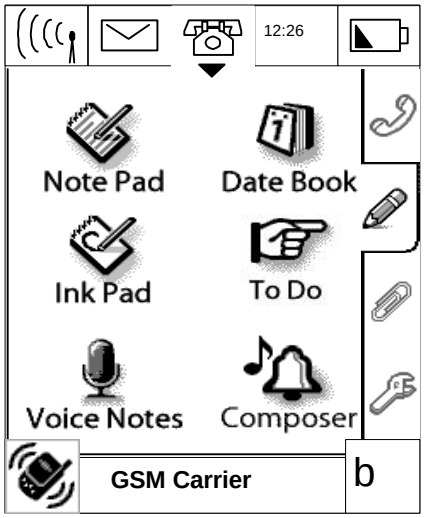
User Interface

The Menu Structure is broken down in to 4 Main Heading, each with Sub-Headings within.

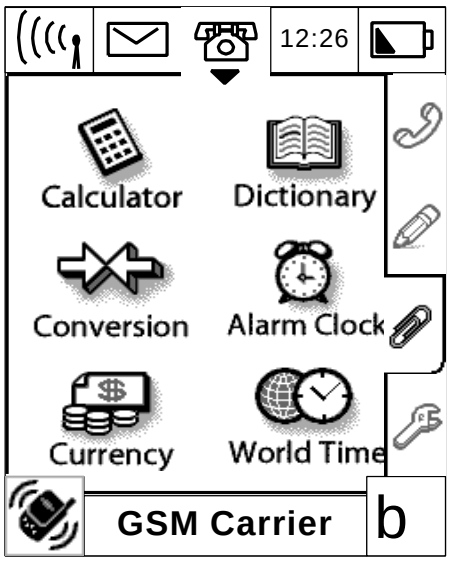
Communicate



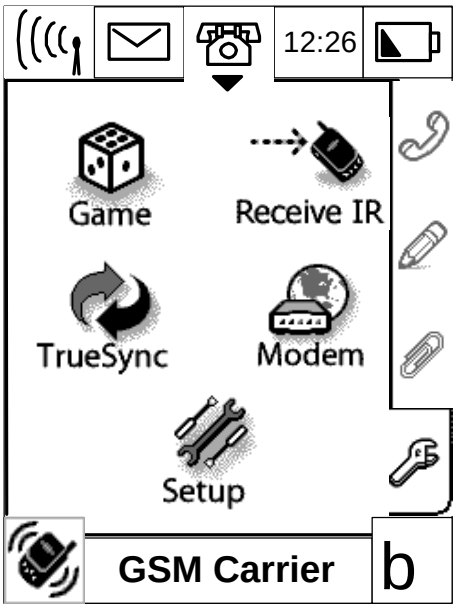
Annotate



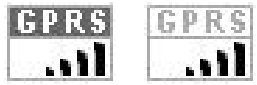
Extras



Tools



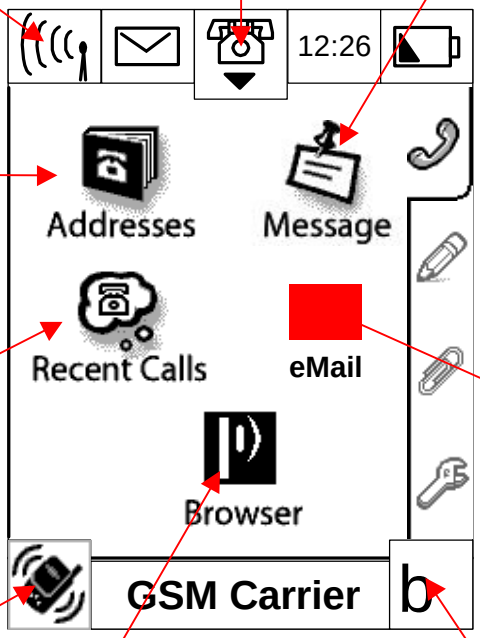
Communicate

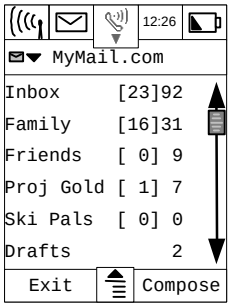


turbo dial

messages
- **print message via IrDA**
- **concatenated messages**
- **folder routing**
- **voice mail access**
- **cell broadcast access**
- **multiple recipients**

address book
- **tap and dial**
- **transfer records via IrDA**
- **print contacts via IrDA**
- **groups**
- **Vcard**





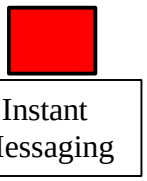
recent calls
- **last 20 missed (page down)**
- **last 20 called (rocker in)**
- **last 20 answered (page up)**

eMail
- **5 mailboxes**
- **POP3, IMAP4, SMTP, MIME**
- **text, ink, Vcard attachment**

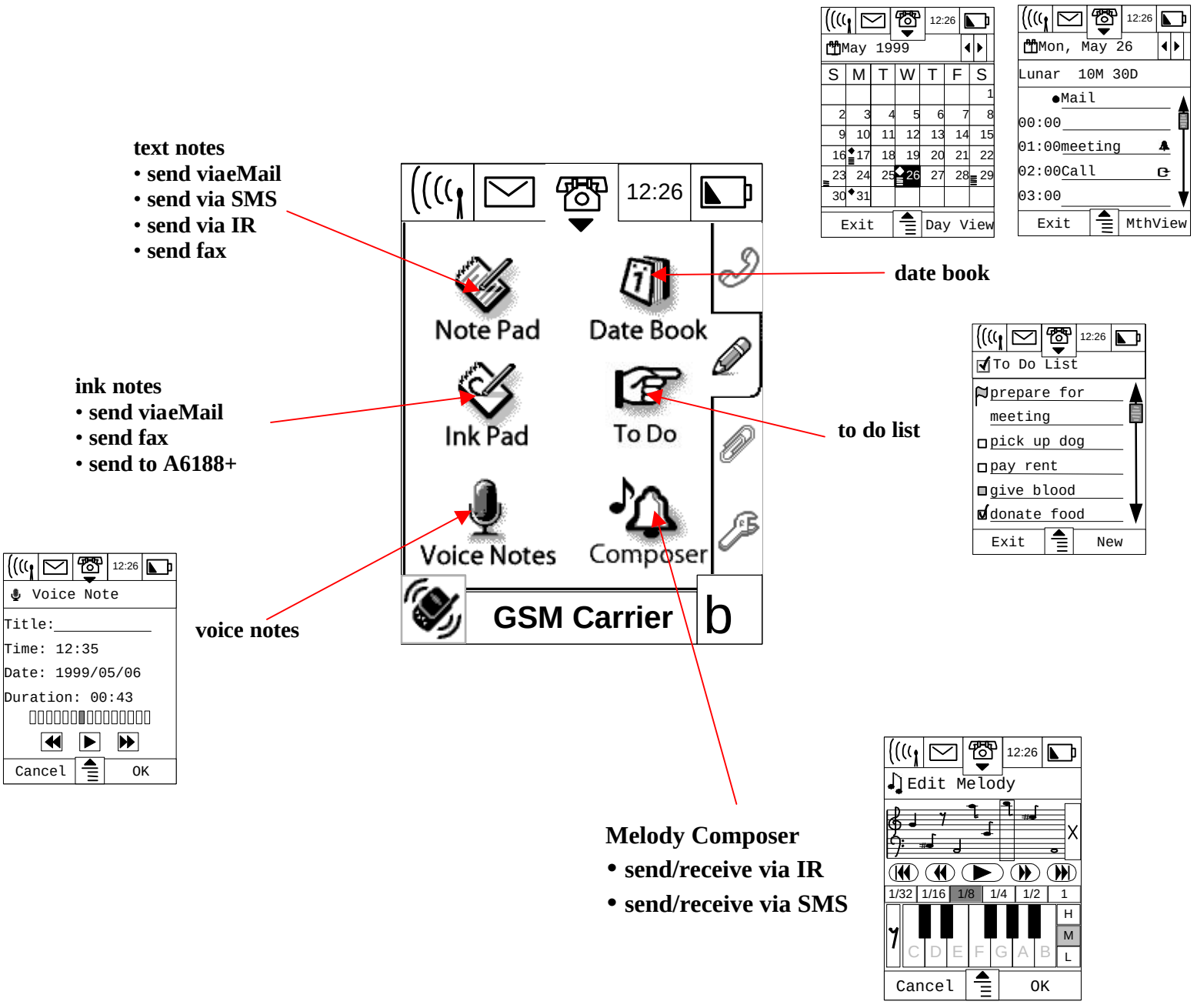
- **call divert icon**

WAP browser
- **4.1.16f Phone.com browser**
- **increased lines/screen**

- **STK access**
- **owner info access**



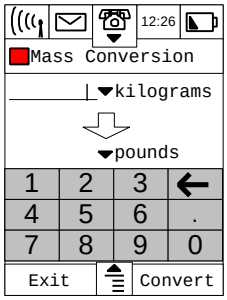
Annotate

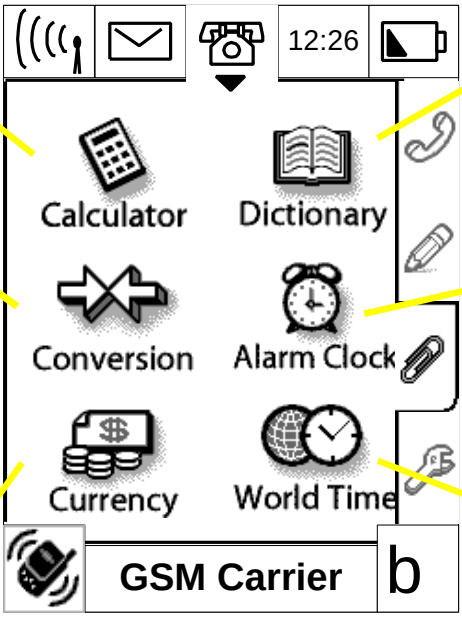

text notes
• send viaeMail
• send via SMS
• send via IR
• send fax
ink notes
• send viaeMail
• send fax
• send to A6188+
voice notes
date book
to do list
Melody Composer
• send/receive via IR
• send/receive via SMS
12:26
Note Pad
Date Book
Ink Pad
To Do
Voice Notes
Composer
GSM Carrier
May 1999
Exit
Day View
Mon, May 26
Lunar 10M 30D
Mail
00:00
01:00meeting
02:00Call
03:00
Exit
MthView
To Do List
prepare for meeting
pick up dog
pay rent
give blood
donate food
Exit
New
Voice Note
Title:
Time: 12:35
Date: 1999/05/06
Duration: 00:43
Cancel
OK
Edit Melody
1/32
1/16
1/8
1/4
1/2
1
H
M
L
Cancel
OK

Extras

calculator
- **basic**
- **scientific**

conversion calculator
- **mass**
- **length**
- **temperature**
- **area**
- **volume**

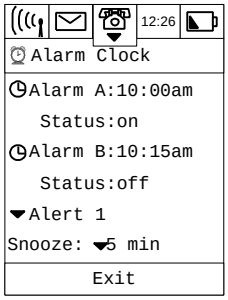




currency calculator
- **27 currencies**
- **conversion log**

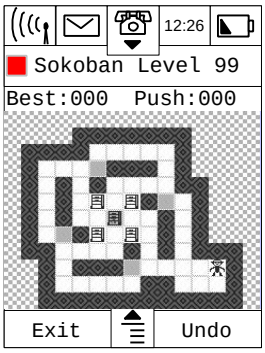
dictionary
- **Chinese-to-English**
- **English-to-Chinese**

alarm clock
- **2 alarms**
- **variable snooze duration**

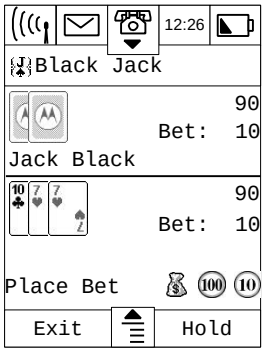


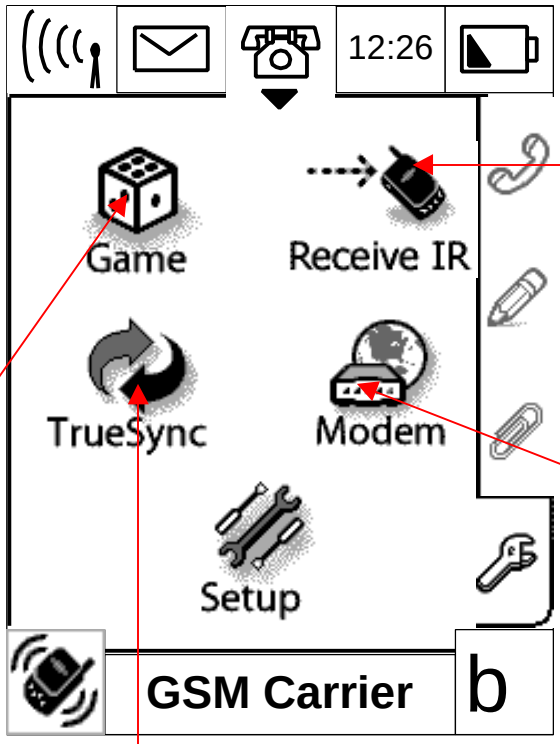
world time

Tools



Games
- **Blackjack**
- **Memory**
- **Sokoban**
- **Hua Rong Dao**
- **Connect five**





Receive IrDA

Soft Modem

Kjava

Truesync
- **address book**
- **date book**
- **to do list**
- **text and ink notes**
- **backup all user data**

Tools and Test Equipment

RSX4043-A	Torque Driver 1 Used to remove and replace screws
	Torque Driver Bit T-6 Plus, Apex 440-6IP Torx Plus or equivalent 1 Used with torque driver
6680388B67	Disassembly tool, plastic with flat and pointed ends 1 Used during assembly / disassembly of device
6680388B01	Delrin Tweezers 1 Used during assembly/disassembly
HP34401A	Digital Multi-meter 2 Used to troubleshoot device

Disassembly

The Procedure in this section provides instructions for the disassembly of the A008.

Removing the Battery Door

1. Remove the Battery door by pushing down on battery retaining catch and sliding battery door down and away from Antenna end of unit.

Removing the Battery

1. Press down on the top of the battery to compress the battery contacts
2. Pull up and away from rear Housing.

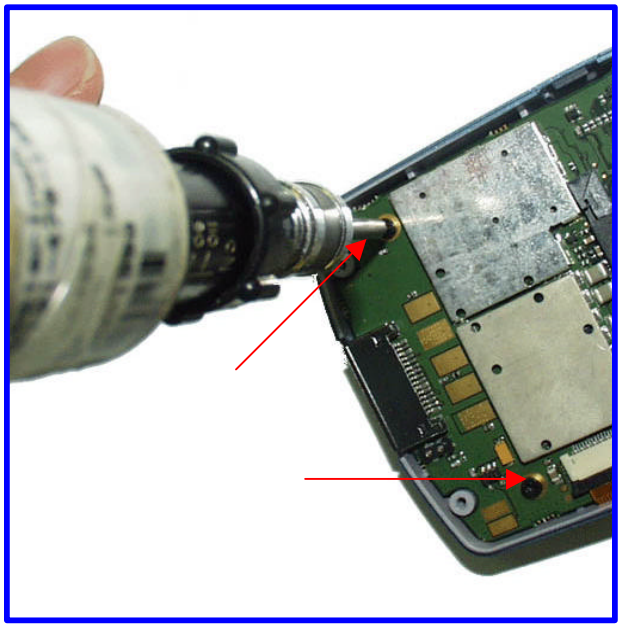
Remove Housing Screws

1. Remove the 4 retaining screws from the top and bottom of the rear housing. Use a T6 Torx driver.

Separate Front and Rear Housing

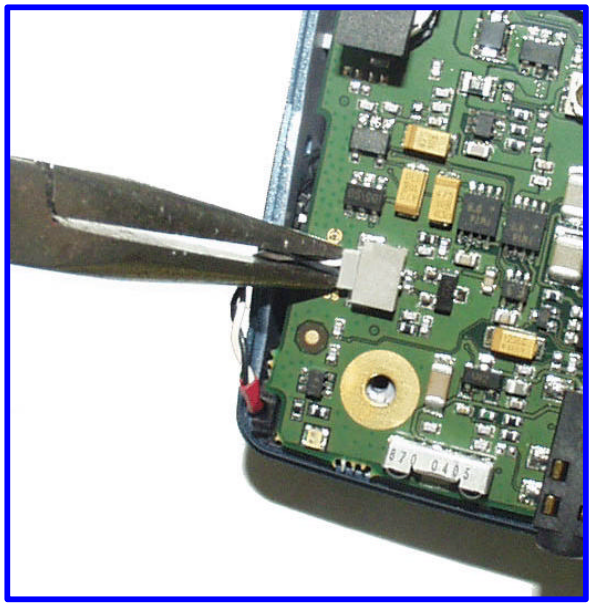
1. Slide a finger nail or a plastic tool between the front and back housing on either side of the phone
2. This will push back the retaining catches; the front housing can then be lifted up over the catches and the rear housing removed.

PCB Screw Removal



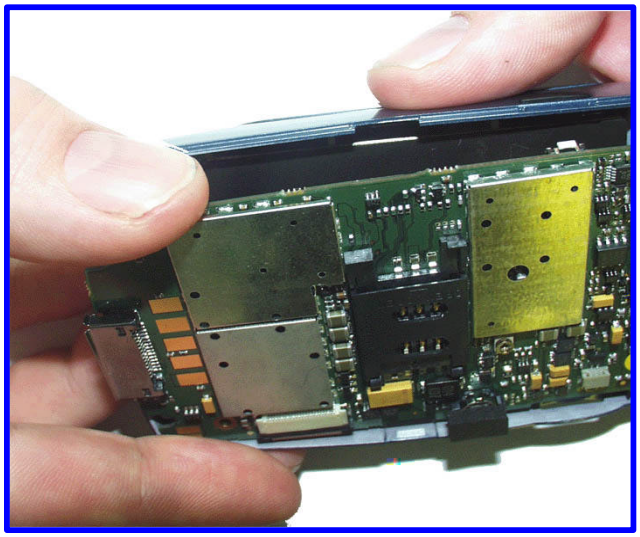
1. Remove the two PCB screws from the bottom of the housing using a T6 Torx driver.

Speaker Connector Removal



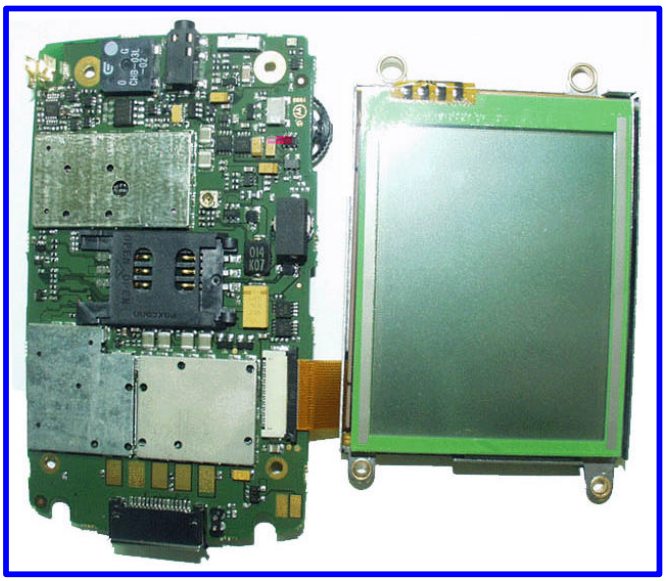
1. Very Carefully extract the 2 Pin speaker connector, using a pair of long nosed pliers.
2. These connecting wires are very susceptible to damage take extra care.

PCB / LCD Removal

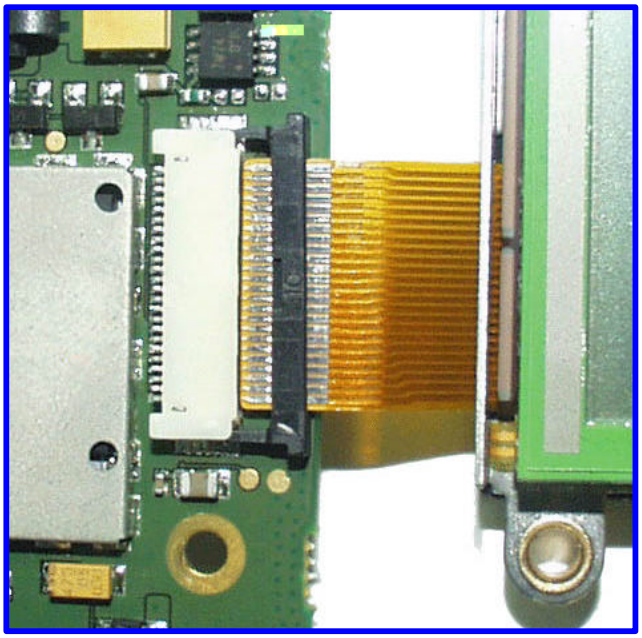


1. Rotate the front hosing, and allow the PCB to drop into the palm of the hand. If necessary use plastic tool to free PCB if at all stuck.

PCB / LCD and Flex Overview



LCD Flex removal



1. Using a plastic tool push the edges of the flex connector forward to release the flex.
2. Gently pull the LCD away from the connector keeping the flex in line with connector.

Subscriber Identity Module (SIM) Cards and Security

Removing the SIM Card

1. Remove the Battery Door and Battery as described in the Disassembly Procedure
2. Holding unit with antenna upwards push black SIM carrier to the right and pull upwards

Cut Corner

Inserting the SIM card

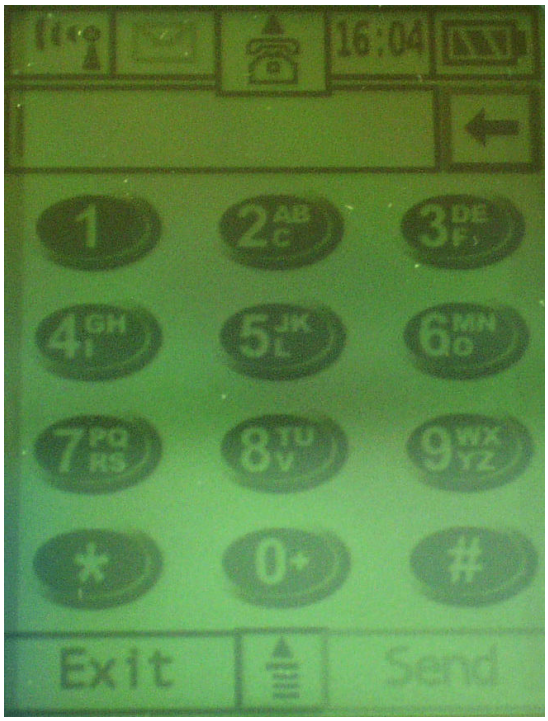
1. Locate the 1 cut corner of the SIM Card; slide the SIM fully into the carrier, gold contacts facing down towards the unit.
2. Push the carrier down and slide to the right

Manual Test Mode

The Aoo8 is equipped with a manual test mode capability. This allows service personnel to manually control electronic functions that would usually be initiated by the product's operating software. This is achieved by the user entering specific test mode commands.

To enter there test commands a GSM / DCS Test SIM card (Part Number 8102430Z04) must be used. See above for SIM Card entry procedure

To enter into test mode the unit should be powered up. Touch the Icon. This will bring up the phone keypad screen.



1. Touch and hold the virtual **#** key, for 3 – 4 seconds. This will initiate test mode.
2. To enter a test mode command, the following sequence must be followed:
A Soft Reset for Example

571 → **#** → **Send**

GSM Test Commands

Key Sequence	Test Function/Name
#(hold down for 2 seconds)	Enter manual test mode
01#	Exit manual test mode
07x#	Mute RX audio path
08#	Unmute RX audio path
09#	Mute TX audio path
10#	Unmute TX audio path
15x#	Generate tone
16#	Mute tone generator
19#	Display S/W version number of Call Processor
*19	Display S/W version number of Dragonball
20#	Display S/W version number of Modem
36#	Initiate acoustic loopback
37#	Stop test
38#	Activate Mini SIM
39#	Deactivate Mini SIM
43x#	Change audio path
47x#	Set audio volume
51#	Enable sidetone
52#	Disable sidetone
57#	Initialise non-volatile memory
58#	Display security code
58xxxxxx#	Modify security code
59#	Display lock code
59xxx#	Modify lock code
60#	Display IMEI
99#	Display all display pixels

15XX#

90#	Vibrator
91#	Ringer

36XX#

0 or Omitted	Full Rate
1	Enhanced Full rate
2	Half Rate

98#

20#	GSM 1800
21#	GSM 900
23#	Dual Band 900 / 1800

Personality Transfer

Personality transfer will be achieved using the Truesync application software.

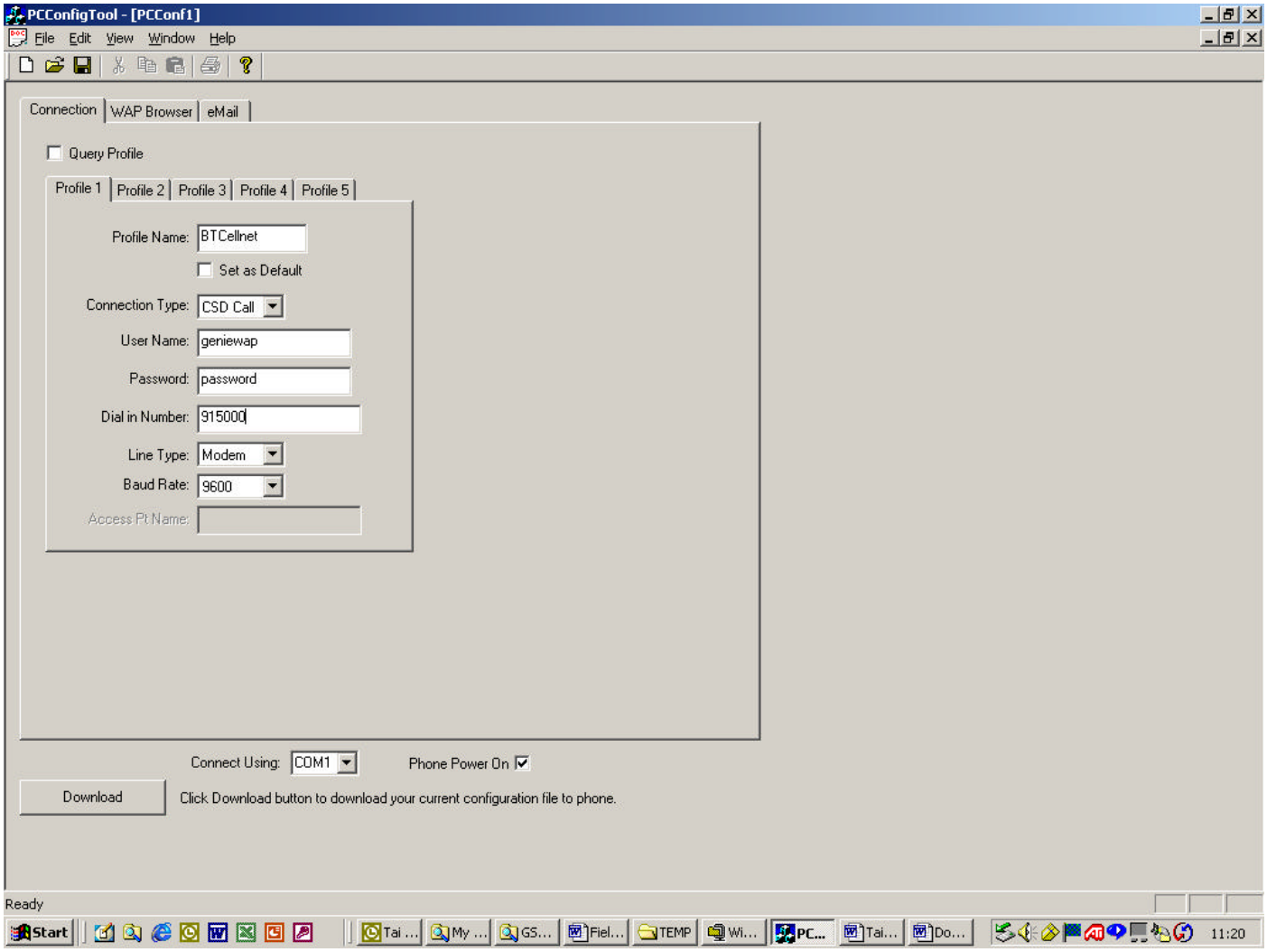
Set up of User Profiles

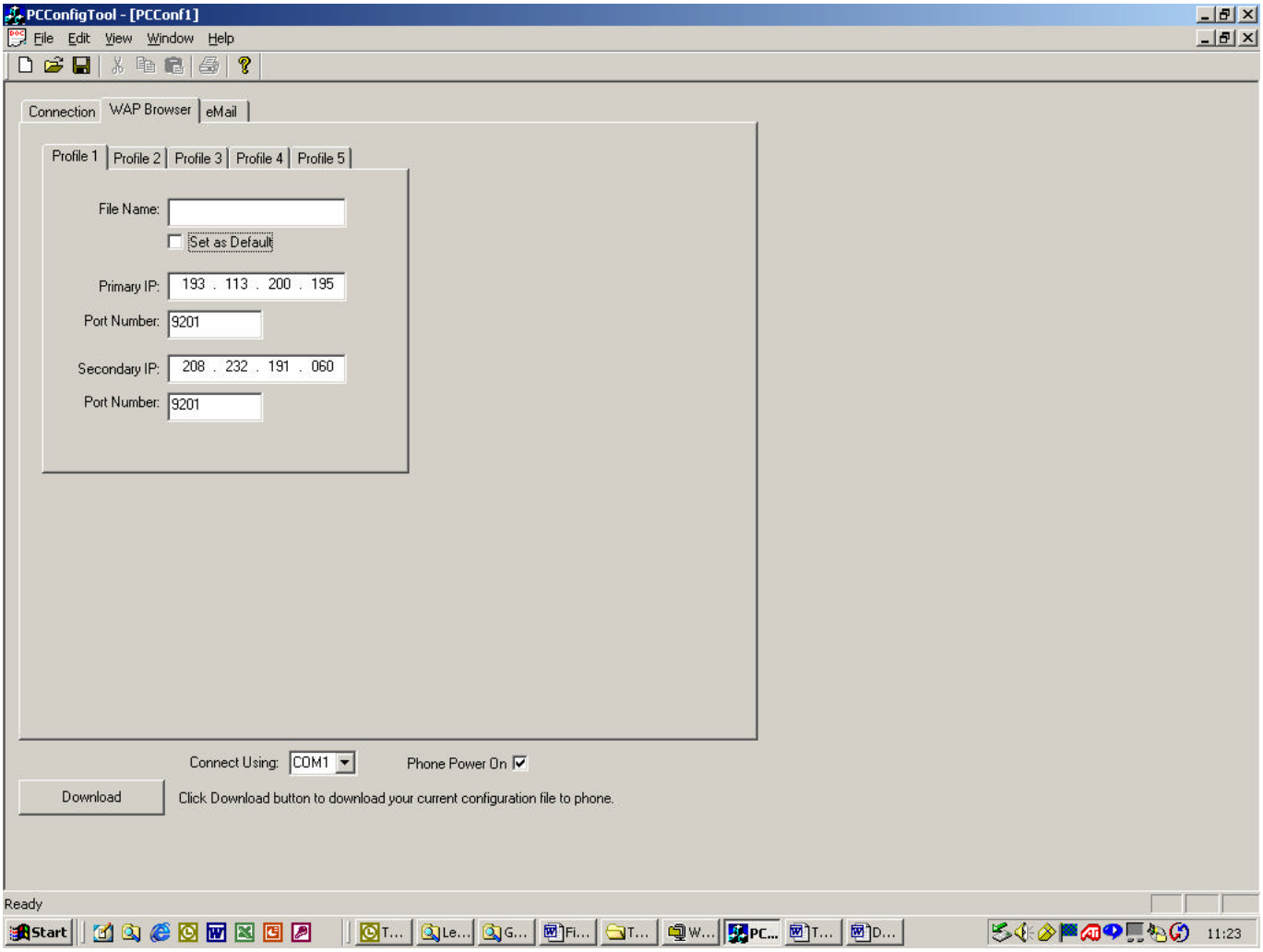
PC Tools is an end user software program, which allows user friendly set up of the A008 WAP, E-Mail and GPRS functions.

Set up of PC Tools is as follows:

1. Open pcc (PC Configuration) document:
From main menu or tool bar, click New to create a new document or Open to open an exist pcc document. The opened document looks like a property sheet.

2. Edit pcc document:
Once you have a document opened, click Connection, WAP Browser, or eMail tab to go to the setup you desired. Enter data into each field.





4. Save pcc document:
From main menu select Save or Save As to save the document.

5. Setup hardware environment:
Connect phone with PC using serial port cable. Also the phone must connected to a power source.

6. Download data to phone:
At the bottom of opened document, select the COM port which you are using to connect PC and phone; if the phone is able to power on, check Phone Power On check box; click Download button to start downloading.

7. Switch phone off and then power the unit back on again.

Identity and Security

Each Motorola GSM Cellular Cassette will be labelled with various number configurations. The following information describes what these configurations mean.

MSN

The mechanical Serial Number (MSN) is an individual unit identity number and will remain with the unit throughout the life of the unit. The MSN can be used to log and track a unit on Motorola's EPPRS system.
The MSN is divided into 4 sections.

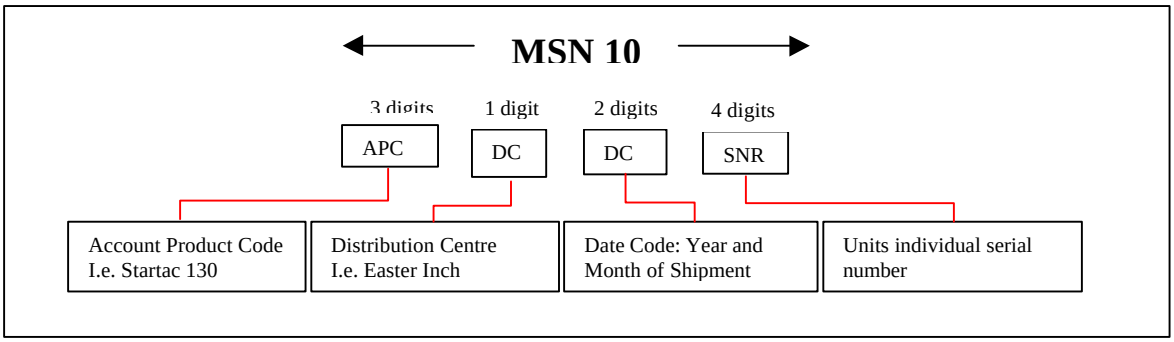


Figure MSN label breakdown

IMEI

The International Mobile station Equipment Identity (IMEI) number is an individual number unique to the PCB and is stored within the unit's memory. The following figure gives a description of the make up of this number.

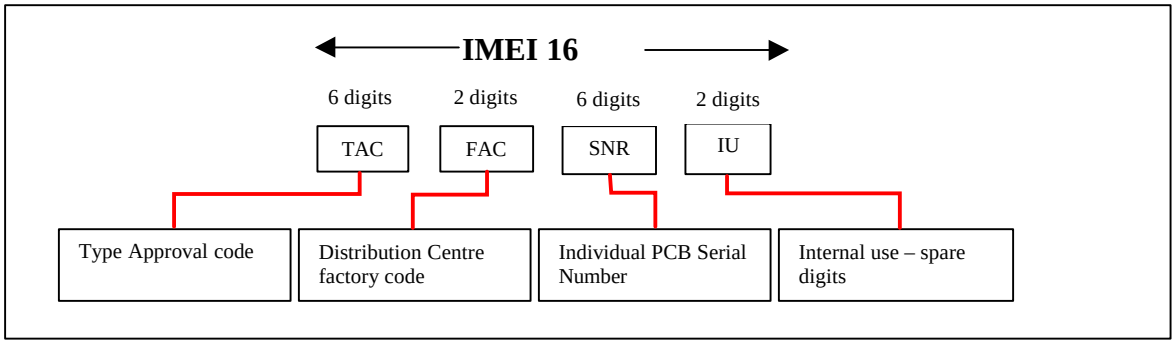
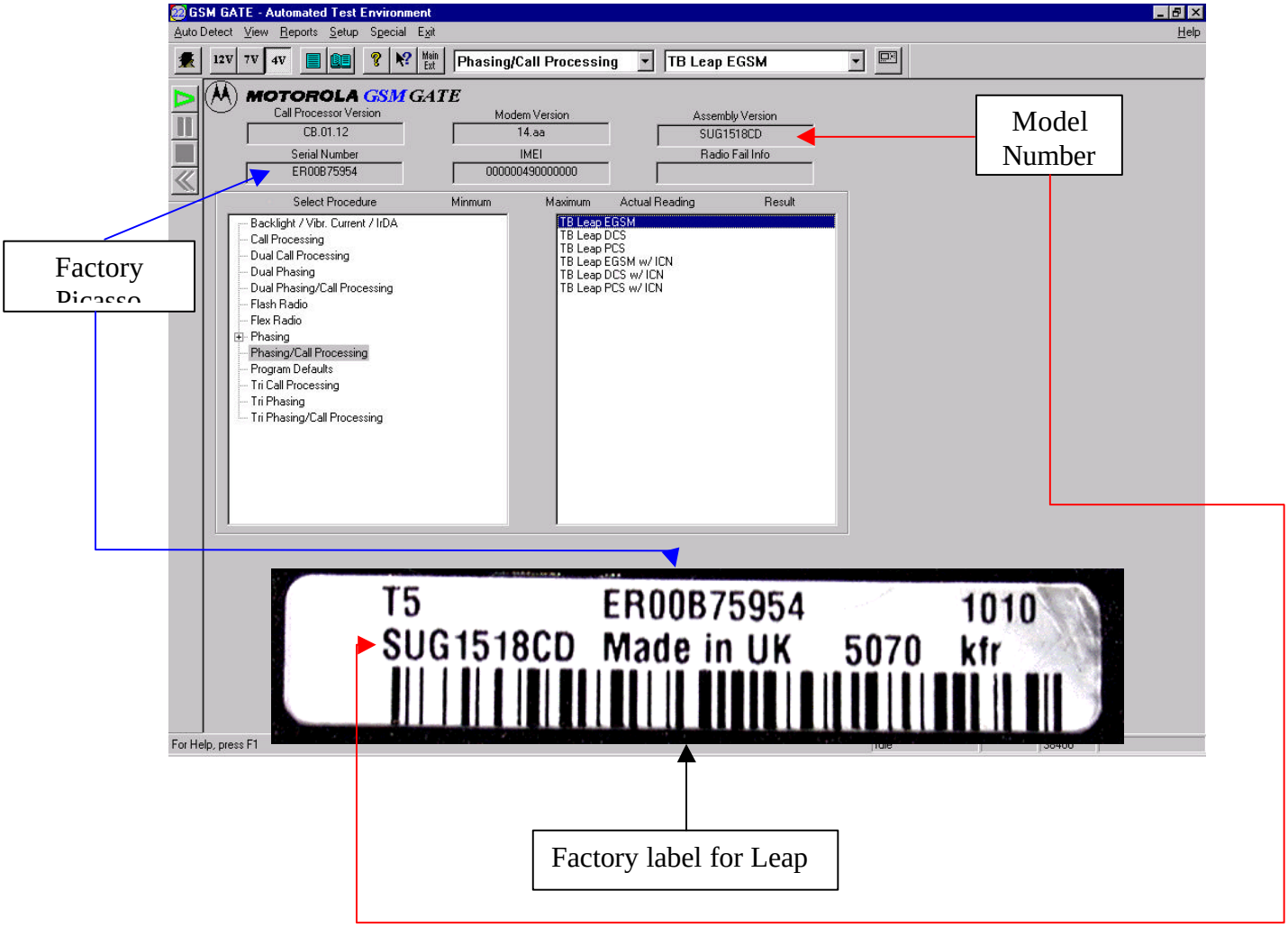


Figure IMEI label breakdown

Some other label number configurations that will be present will be: -
XCVR NUMBER: Identifies type of product. i.e. L7389i (Usually SWF number)

Package Number: Determines type of equipment, mode in which it was shipped and language with which it was shipped.

Picasso Labelling



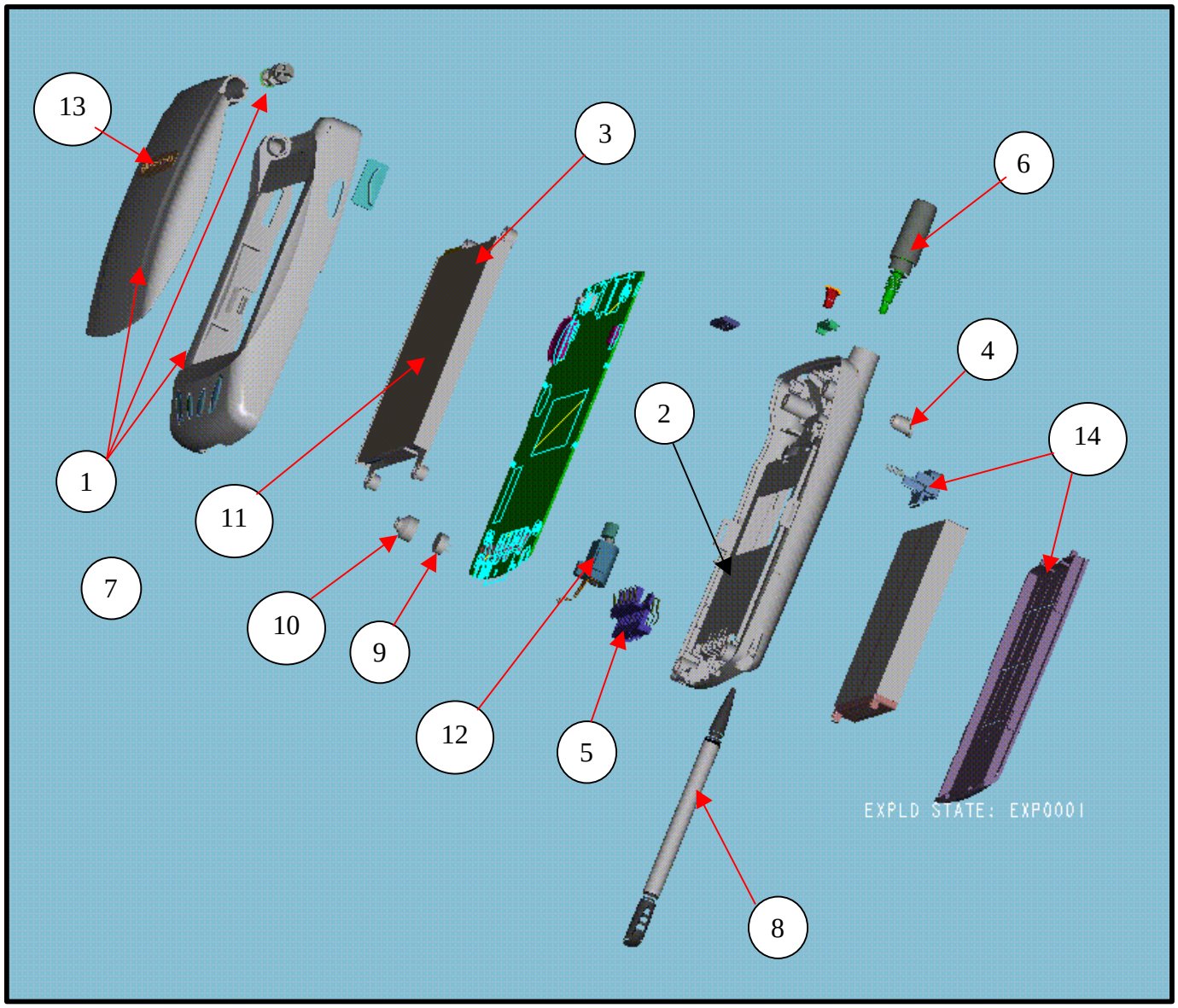
Picasso is the new factory tracking system. It is being implemented globally in all Motorola and out-sourcing manufacturing sites throughout 2000. For all field failures, Service currently records the MSN to validate the warranty period and record which site shipped the phone. By recording the Picasso number in addition to the MSN, we can perform the normal validations but also attribute all field failures back to original site, shift and line of manufacture.

Sales Model Numbers

SA0037A	A6188+, SCCD, Grey Mica, Full Package, PRC
SA0034A	A6188+, SCCD, Grey Mica, Full Package, HK Cellstar
SA0039A	A6188+, TCCD, Grey Mica, Simple Package, HK
SA0043A	A6188+, TCCD, Grey Mica, Simple Package, TW

* Initial release to Greater China only

Exploded View Diagram



Exploded View Parts List

CHYN4209A	1	Flip & Front Assembly, Grey Mica
0164617E05	2	Rear Housing, Grey Mica
CHHN4213A	3	LCD Module
7564435E01	4	Rubber Foot x2
3264662E01	5	Battery Pad
0164481E01	6	Antenna Assembly
0364579E01	7	Screw x6
0164027E01	8	Stylus Assembly
5009135L07	9	Microphone
0564533E01	10	Mic Grommet
5464580E01	11	LCD Protector
5964466E01	12	Motor Assembly
1364832E03	13	Logo A6188+, Grey Mica
CHYN4207A	14	Battery Door, Grey Mica

Accessories

Battery
· Lithium Ion Battery (Slim) ~800mAh (1 hour rapid charge)
· Label must meet all countries specific requirements
· Reuse A6188 battery

Battery Door
· Reuse A6188 Battery door but with A008 specific colours
– Mica Grey, TT Silver

Data Cable (Serial cable)
· Lever shifter for RS232 communication
· No PC card required. Cable hooks directly to RS232 port of PC
· Reuse A6188 Data cable

Travel Charger
· A Travel Charger similar to the existing SPN4604 but its plug should meet the PRC
National Standard, Hong Kong Safety requirements and respective regulatory and
Countries standard in EMEA and Brazil.
· Kramer charger reuse (SPN 4654A)
· Labels must meet all countries specific requirements.

Charger Base & Docking station (Cradle)
The Charger base & Docking Station should be able to
· Fast charge the battery inside the phone
· It should be able to charge a spare battery in the rear pocket
· Display the charging status of the battery inside the phone, a standalone battery,
and indicate data transfer
· The Transformer should be able to connect to the charger base Hirose socket
· Have True-Sync SW data transfer capability
· The front slot of the charger base should be able to hold the phone in upright
Position (docked) and if the serial cable is connected (between the Transformer
Hirose plug and the PC), it should be able to do all the communication with PC

· Labels must meet all the countries specific requirements
· Reuse A6188 Cradle. ID modification will not affect Cradle design

Vehicle Power Adapter
· Powers the phone and rapid charges the battery from vehicle' s cigarette lighter
Socket
· Reuse A6188 VPA

Silver Headset
· Hand free operation, walk and Talk.
· Reuse P7689 headset

Leather Holster
· Stylish leather holster. Prefer local source to reduce cost.
· Will not create problem to remove the stylus B, making and answer a call, and
operate with headset

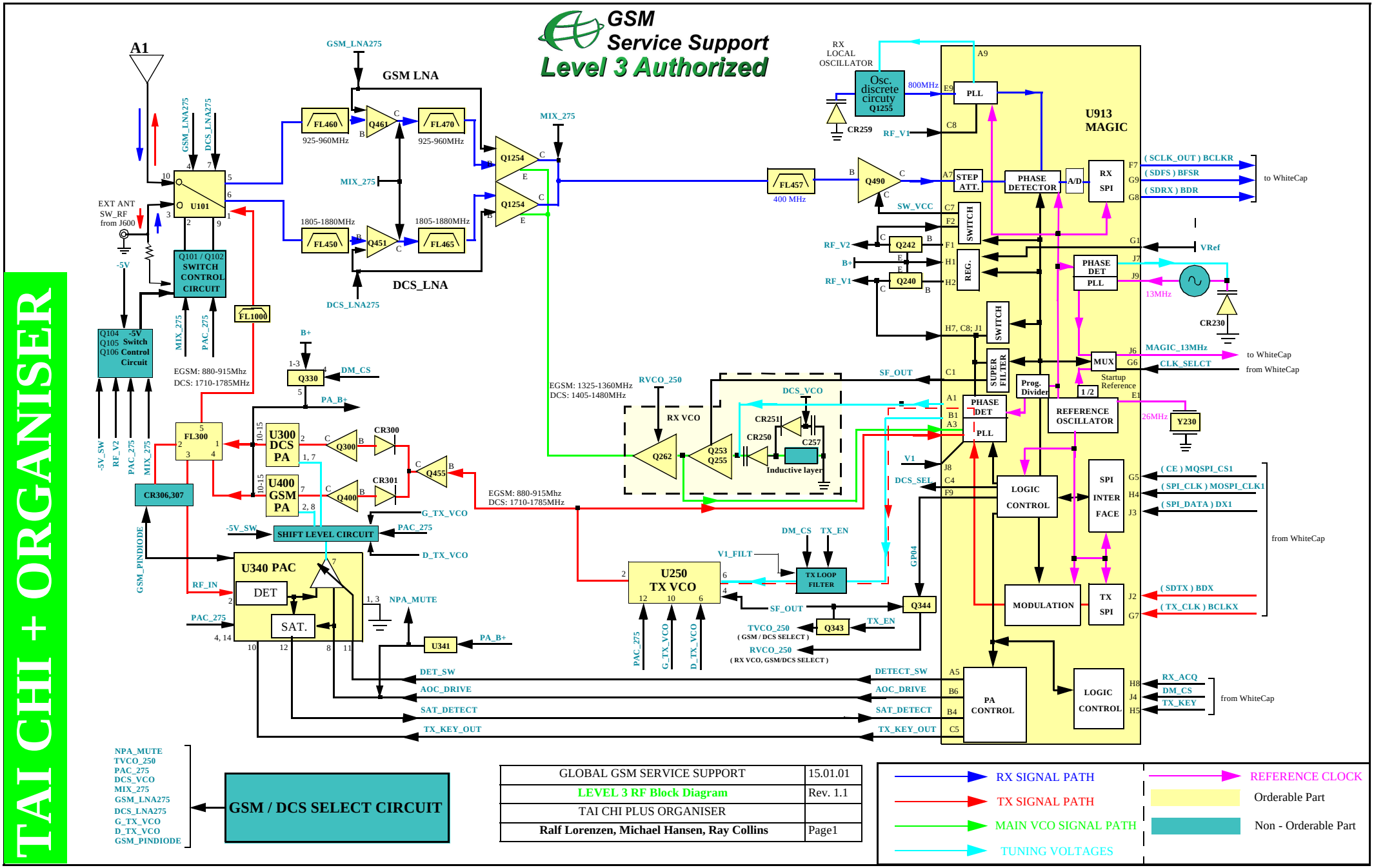
Starfish True Sync CDROM Kit
· Able to support Win95/98/2K/NT and Palm (English)
· Recorded in a CDROM and bundle sales with Cradle
· Package comes in kit with proper packaging d Quick Start Up guides in English and
localised language support by the software.
· New CDROM kit since new features were added and with EMEA languages.

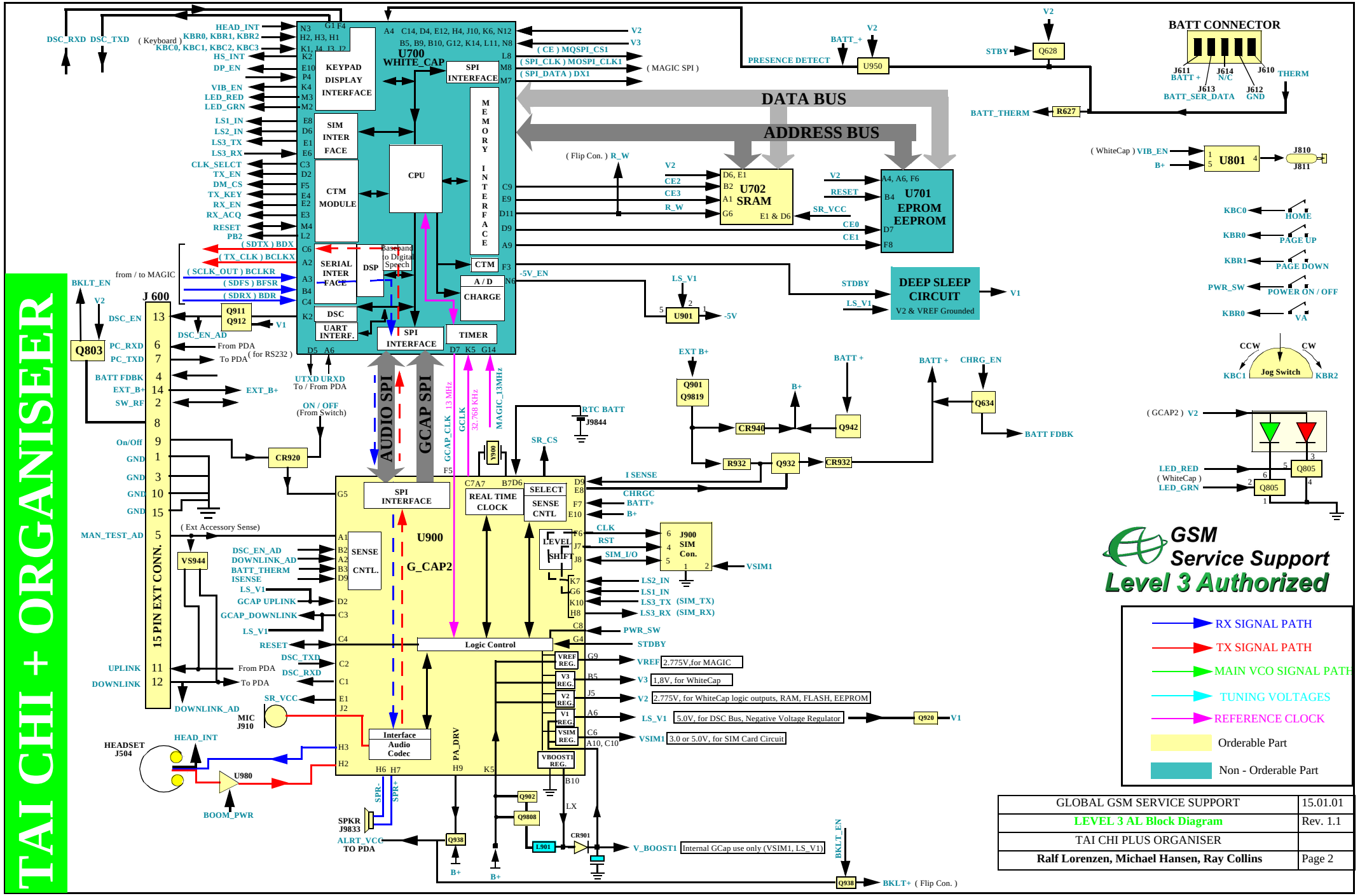
Plug
· Per the standard plug specified by each supported country.

Car Kit
· DSP easy install car kit.

Stylus
· Stylus A – Retractable and able to fit well in the fitting slot of A008 rear housing.
· Stylus B – Pen type that can fit in the Stylus pocket of the leather case.

SPN4830A	Cradle(Chinese)
SKN6133A	Sync Cable
SPN4654A	Travel Charger
SPN4659A	Travel Charger (UK Plug)
SYN7455A	UK Plug
SPN4604A	Travel Charger (US Plug)
SNN5713A	Battery (Chinese)
SNN5712A	Battery (English with CE) X2
CHYN4201A	Leather Case
AAYN4264A	Headsets
1364832E03	Logo A6188+, Grey Mica
CHYN4207A	Battery Door, Grey Mica
CHVN4103B	Truesync Kit
CHJN4219A	Manual, SC Version
SJN9785A	Manual, TC Version
SJJN4107A	Manual, English Version
5564831E01	Unit Box, PRC
5564831E02	Unit Box, TW
5664504E01	Pulp Tray, PRC+TW
5689407K01	Pulp Tray, HK
AAYN4290A	Sling with Stylus Pen
SYN9070A	DGT Label

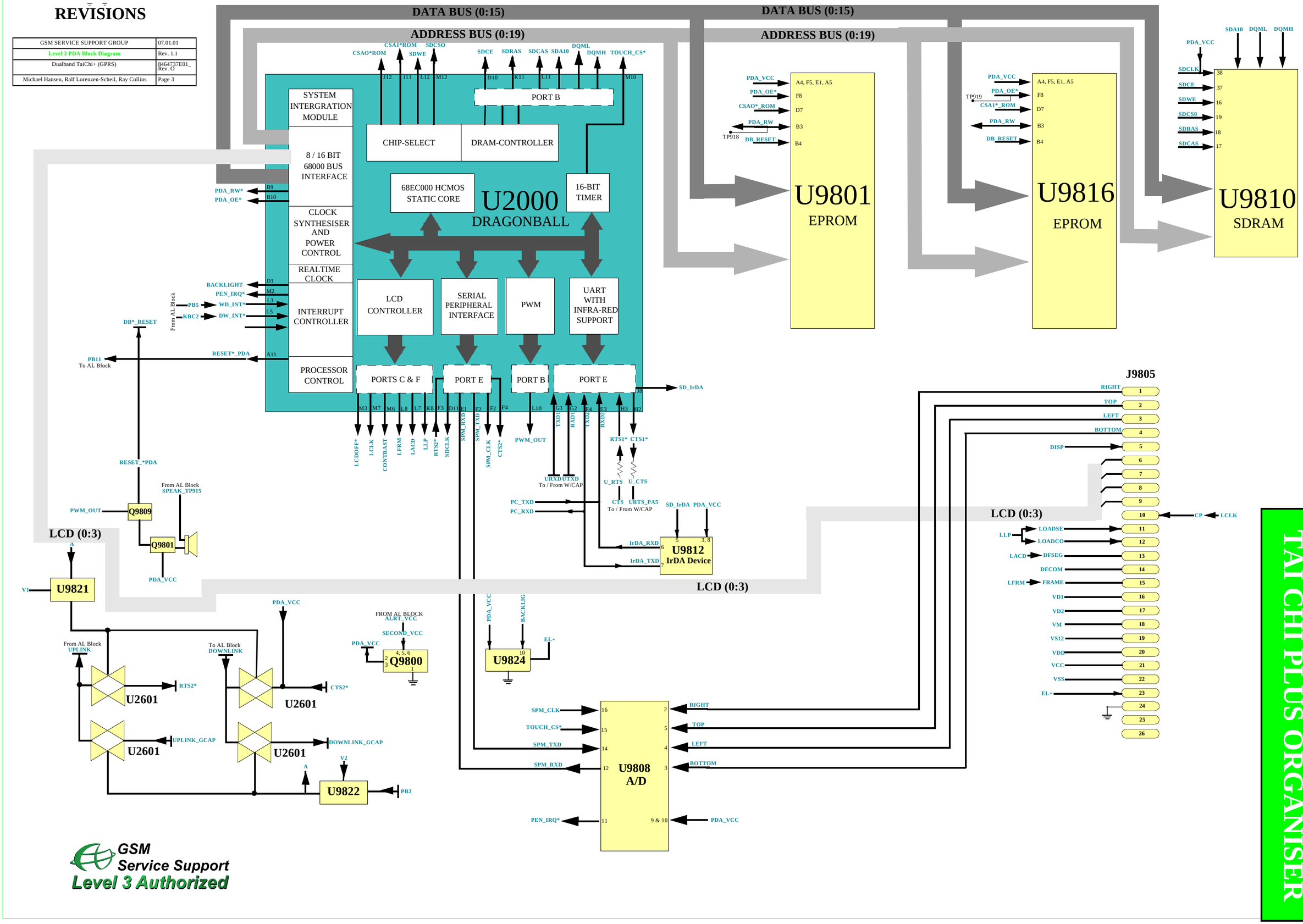

TAI CHI + ORGANISER
GSM Service Support
Level 3 Authorized
A1
GSM_LNA275
GSM LNA
FL460
925-960MHz
Q461
FL470
925-960MHz
MIX_275
Q1254
Q1254
1805-1880MHz
FL450
Q451
FL465
1805-1880MHz
DCS_LNA
DCS_LNA275
GSM_LNA275
DCS_LNA275
U101
EXT ANT
SW_RF
from J600
-5V
Q101 / Q102
SWITCH
CONTROL
CIRCUIT
FL1000
MIX_275
PAC_275
Q104 -5V
Q105 Switch
Q106 Control
Circuit
EGSM: 880-915Mhz
DCS: 1710-1785MHz
B+
Q330
DM_CS
PA_B+
FL300
U300
DCS
PA
U400
GSM
PA
Q300
Q400
Q455
CR300
CR301
CR306,307
GSM_PINDIODE
-5V_SW
RF_V2
PAC_275
MIX_275
SHIFT LEVEL CIRCUIT
G_TX_VCO
D_TX_VCO
U340 PAC
DET
SAT.
RF_IN
PAC_275
NPA_MUTE
U341
PA_B+
DET_SW
AOC_DRIVE
SAT_DETECT
TX_KEY_OUT
EGSM: 880-915Mhz
DCS: 1710-1785MHz
EGSM: 1325-1360MHz
DCS: 1405-1480MHz
RVCO_250
RX VCO
Q262
Q253
Q255
DCS_VCO
CR251
CR250
C257
Inductive layer
SF_OUT
U250
TX VCO
V1_FILT
TX LOOP
FILTER
DM_CS
TX_EN
Q344
Q343
TVCO_250
(GSM / DCS SELECT)
RVCO_250
(RX VCO, GSM/DCS SELECT)
PAC_275
G_TX_VCO
D_TX_VCO
GP04
RX
LOCAL
OSCILLATOR
Osc.
discrete
circuty
Q1255
800MHz
CR259
RF_V1
FL457
400 MHz
Q490
SW_VCC
RF_V2
Q242
B+
RF_V1
Q240
U913
MAGIC
PLL
STEP
ATT.
PHASE
DETECTOR
A/D
RX
SPI
SWITCH
REG.
SWITCH
SUPER
FILTER
Prog.
Divider
1 /2
PHASE
DET
PLL
REFERENCE
OSCILLATOR
MUX
Startup
Reference
PHASE
DET
PLL
LOGIC
CONTROL
SPI
INTER
FACE
MODULATION
TX
SPI
PA
CONTROL
LOGIC
CONTROL
(SCLK_OUT) BCLKR
(SDFS) BFSR
(SDRX) BDR
to WhiteCap
VRef
13MHz
CR230
MAGIC_13MHz
to WhiteCap
CLK_SELCT
from WhiteCap
26MHz
Y230
(CE) MQSPI_CS1
(SPI_CLK) MOSPI_CLK1
(SPI_DATA) DX1
from WhiteCap
(SDTX) BDX
(TX_CLK) BCLKX
RX_ACQ
DM_CS
TX_KEY
from WhiteCap
DETECT_SW
AOC_DRIVE
SAT_DETECT
TX_KEY_OUT
V1
DCS_SEL
NPA_MUTE
TVCO_250
PAC_275
DCS_VCO
MIX_275
GSM_LNA275
DCS_LNA275
G_TX_VCO
D_TX_VCO
GSM_PINDIODE
GSM / DCS SELECT CIRCUIT
GLOBAL GSM SERVICE SUPPORT
15.01.01
LEVEL 3 RF Block Diagram
Rev. 1.1
TAI CHI PLUS ORGANISER
Ralf Lorenzen, Michael Hansen, Ray Collins
Page1
RX SIGNAL PATH
TX SIGNAL PATH
MAIN VCO SIGNAL PATH
TUNING VOLTAGES
REFERENCE CLOCK
Orderable Part
Non - Orderable Part



GLOBAL GSM SERVICE SUPPORT	15.01.01
LEVEL 3 AL Block Diagram	Rev. 1.1
TAI CHI PLUS ORGANISER	
Ralf Lorenzen, Michael Hansen, Ray Collins	Page 2

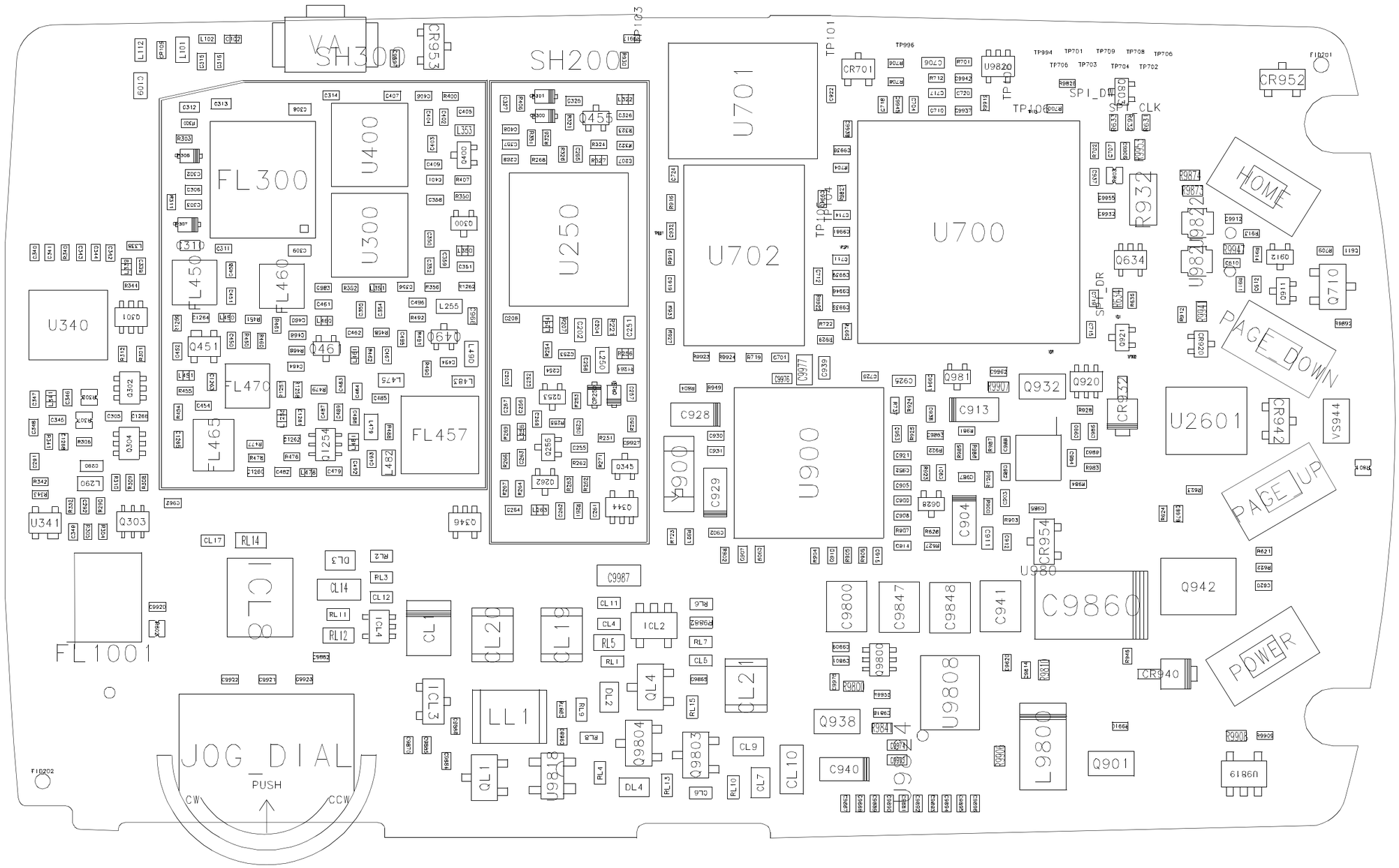
REVISIONS

GSM SERVICE SUPPORT GROUP	07.01.01
Level 3 PDA Block Diagram	Rev. 1.1
Dualband TaiChi+ (GPRS)	84647370E01_ Rev. O
Michael Hansen, Ralf Lorenzen-Scheil, Ray Collins	Page 3



DualBand TaiChi+ (GPRS)_8464737E01_Rev.O

GSM Service Support
Level 3 Authorized



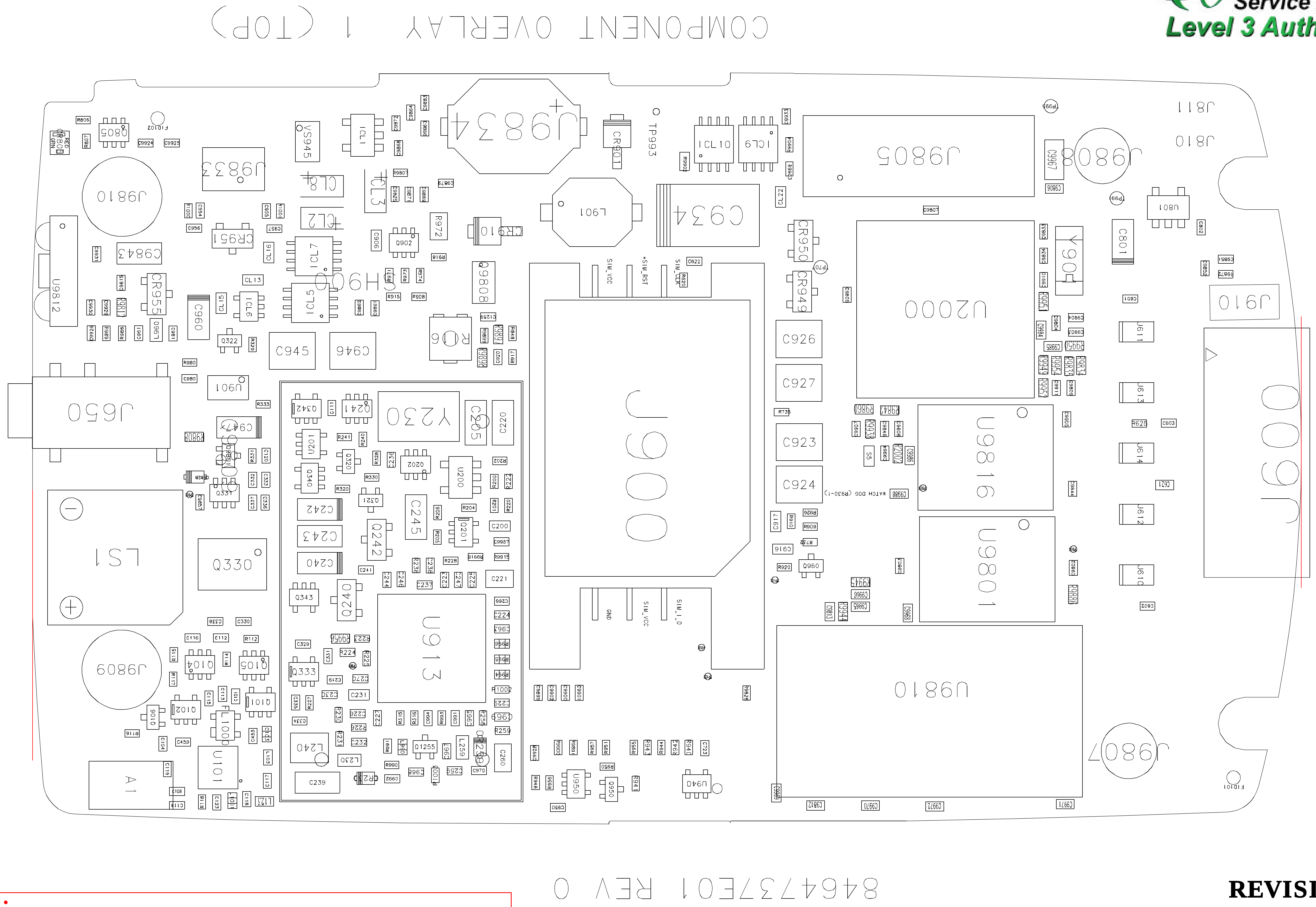
Note :
This drawing refers only to the first PCB-Version of the product !

REVISIONS

GSM SERVICE SUPPORT GROUP	02.01.2001
Level 3 Layout	Rev. 1.0
Dualband TaiChi+ (GPRS)	8464737E01_ Rev. O
Michael Hansen, Ralf Lorenzen-Scheil, Ray Collins	Page 2 of 2

DualBand TaiChi+ (GPRS)_8464737E01_Rev.O

GSM Service Support
Level 3 Authorized



Note :
This drawing refers only to the first PCB-Version of the product !

REVISIONS

GSM SERVICE SUPPORT GROUP	02.01.2001
Level 3 Layout	Rev. 1.0
Dualband TaiChi+ (GPRS)	8464737E01_ Rev. O
Michael Hansen, Ralf Lorenzen-Scheil, Ray Collins	Page 1 of 2

MOTOROLA

Personal Communications Sector

GSM Service Support Level 3 Authorized

A008 / A6188 +

GSM Service Support

Training - Documentation - Engineering

Level 3
Circuit Description
03 / 03 / 01
V1.1

A6188 Level 3 Product Guide

RF: Receive

1) The RF Signal from the base station is received through the Antenna A1 and is fed to RF Switch U101, This connects RF to the Aux RF port or the antenna, and isolates TX from RX. The switch is controlled primarily by the following signals **SW_RF:** This is a 50Ω load signal from **Pin 2** of the Accessory Socket J600, when an external device is attached. RX / TX isolation is achieved using the negatively biased signals from Q101 and Q102. These devices use the signals **MIX_275** (**RX_EN + RF_V2** through Q340) and **PAC_275** (**TX_EN + RF_V2** through Q321 and Q320) to produce the Transmit and Receive switching signals. The negative bias is produced using **-5V** through Q104, Q105, these 2 transistors are used to provide the RF Switch with the correct switching voltages (for RX Mode 0 – 2.7V, for TX Mode –5V to 2.7V) and Q106 is used to change the output path between Antenna and Buttplug. The control signals from Q101 and Q102 are then fed to **Pins 2** and **9** of the RF switch. These 3 signals, supported by the voltages **GSM_LNA275** (**MIX_275 + GSM_SEL**) and **DCS_LNAS275** (**DCS_SEL and MIX_275**) both through Q342 select whether the signal is Transmitted or Received.

2) Provided **MIX_275** is high, then the received signal will be passed to the band pass filter FL460, for GSM 900 and to FL450 for GSM 1800. The filters will then pass the frequency range (GSM 1800 or GSM900), and remove any existing harmonics or other unwanted frequencies.

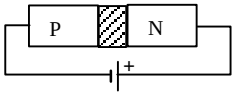
3) The signal will be fed into the appropriate Low noise Amplifier Circuit, Q461 for GSM 900 and Q451 for DCS. This part of the circuit is critical in the achievement of a very low signal to noise ratio, therefore as can be seen around the actual amplifiers, a large amount of external frequency matching and noise reduction circuitry is involved. The LNA's are supported by **MIX_275** and are biased on or off by **GSM_LNA275** for Q461and **DCS_LNAS275** for Q451.

4) The appropriate signal is then fed onto FL470 (For GSM 900 or FL465 (For GSM 1800) where any harmonics created during amplification are removed.

5) The amplified signal is now injected to the base of the dual transistor mixer Q1254. Both mixers are supported by **MIX_275** (Q340).The tuned emitter biasing voltage is provided by **GSM_LNA275** (Q342) and **DCS_LNA275** (Q342)

6) The RX VCO Varactor CR250. Is the active component used within the RX VCO, basically a Varactor diode works in the following way:
When a reverse voltage is applid to a PN junction , the holes in the p-region are attracted to the anode terminal and electrons in the n-region are attracted to the cathode terminal creating a region where there is little current.This region ,the depletion region, is essentially devoid of carriers and behaves as the dielectric of a capacitor.
The depletion region increases as reverse voltage across it increases; and since capacitance varies inversely as dielectic thickness, the junction capacitance will

decrease as the voltage across the PN junction increases. So by varying the reverse voltage across a PN junction the junction capacitance can be varied .This is shown in the typical varactor voltage-capacitance curve below. **Fig 6.1.** This variable



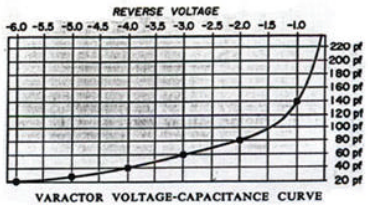


Fig 6.1

capacitence can then be used along with the inductive strip (PCB Tracks lying very close) to provide a LC tuning resonant circuit.
The tuning voltage for the varactor is provided by **CP_RX** (MAGIC U913 **Pin A1**). The VCO amplification is made up of 3 transistor stages Q253, Q255 and Q262, these are supported by the voltage **RVCO_250** (**SF_OUT** through Q344). The collector output from Q255 provides the Phase locked loop feedback to the MAGIC IC **Pin A3,** to ensure the RX VCO frequency changes in line with the Received signal to give the correct IF.

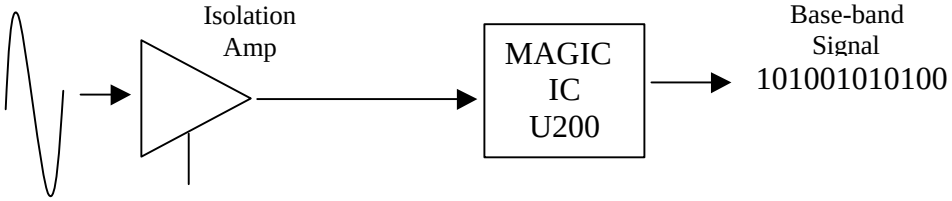
7) Within the mixer, the received frequency and the RX VCO frequencies are mixed sum and difference signals are created, it will be the difference signal of 400Mhz that will be created.

8) The – IF, is now fed to the SAW FL457 filter (Surface Acoustic Wave), this filter is the same as was used in previous 400MHz products. The purpose of the SAW filter is to provide comprehensive removal of harmonics created during the mixing process. The reason the IF was changed from 215Mhz to 400Mhz was for the following reason:

Description	IF	Channel	Received Frequency	RX VCO Frequency	Difference
EGSM L Channel	400Mhz	975	925.2Mhz	1325.2Mhz	154.6Mhz
DCS H Channel	400Mhz	885	1879.8Mhz	1479.8Mhz	
EGSM L Channel	215Mhz	975	925.2Mhz	1140.2Mhz	524.6Mhz
DCS L Channel	215Mhz	810	1879.8Mhz	1664.8Mhz	

The above table demonstrates that if 215Mhz were used instead of 400Mhz, the RX VCO would be required to operate over an extra 370Mhz. With this need eliminated, the part count and therefore the cost are reduced.

9) The 400Mhz IF signal is then passed to the Isolation Amplifier Q490
The purpose of an Isolation Amp is to couple an analogue signal to adjoining parts of a circuit with 2 different grounds. Also to protect the base band signals produced in MAGIC from any stray RF. The Isolation Amp is supported by **SW_VCC** (MAGIC U200 **Pin C7**)



10) The signal is then passed to the MAGIC IC U200 **PRE IN Pin A7**

11) The signal is demodulated internally using an external Varactor diode RX Local Oscillator set up CR259, which is driven by **LO2 CP Pin A9** of MAGIC U200.

12) Where in earlier products, we used to have **RX RXQ, and I** these signals are now only used in digital form within the MAGIC and cannot be measured without technical set up. The demodulated signal is now converted internally to digital form to be passed along an RX SPI bus to the Whitecap.

13) The **RX SPI** signal is made up of **BDR** (Base band Data Receive), **BFSR** (Base band Frame Synch Receive) and **BCLKR** (Base band Clock Receive, fed from MAGIC **Pins G8, G9 and F7** respectively.

14) The Whitecap U800 receives these signals on **Pins A3, D4 and B4,** within the Whitecap the signal is digitally processed. Baud rate reduced, Error correction bits removed, etc…

15) The digital signal is now being fed down the **DIG_AUD** SPI bus to the GCAP II U900, internally to the GCAP, the digital signal is converted to analogue and distributed to the correct outputs

16) For Earpiece, from GCAP II **Pins H6 and H7** to Speaker Pads J9833 **Pins 1 and 2**

17) The Alert is generated within the Dragon ball IC U2000, and not GCAP II given the appropriate data from the incoming signal, SMS, call etc… an interrupt from the alert is fed back to the GCAP, via the signal **SPEAK_TP915**. This signal is supported by the signal **PDA_VCC** (**ALRT_VCC** (Q938 on AL) to **SECOND_VCC** (PDA) and then to **PDA_VCC** through Q9800.

18) For the headset only the **SPKR-** signal is used GCAP II **Pin H6** and feeds the Headset Connector J650, **Pin 3**.

RF: Transmit

1) There are 2 Mic inputs, firstly from the Xcvr mic J910 **Pin 2**, where the analogue input is fed to the GCAP II U900 **Pin J2**

2) Secondly the analogue voice can be fed from the Aux Mic attached to the headset and will be routed from **connection 1** of the Headset Jack J504, through to GCAP II, **Pin H3**. The Aux mic input is amplified through U980 which is supported by **BOOM_PWR** (**BOOM_EN**-Whitecap +**V2**)

3) Within the GCAP II the analogue audio will be converted to digital and clocked out onto the **DIG_AUD** SPI bus to the Whitecap U800.

4) It is within the Whitecap that all information about the transmission burst is formulated i.e. The timing of the burst / The channel to transmit on / The error correction protocol / In which frame the information will be carried to the base station, etc, etc…

5) All this information is then added to the digitised audio and is transferred to the MAGIC U200 along the TX SPI bus. The bus is made up of **BCLKX** (Base band Clock Transmit) **Pin B3** and **BDX** (Base band Data Transmit) **Pin B6**. The timing for

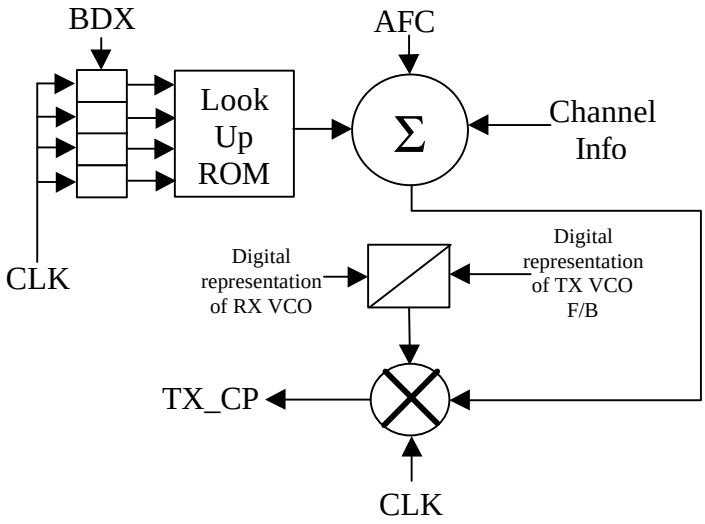
this data is already decided for the transmission burst, and therefore a frame synch is not required.

6) The SPI bus signals enters into the MAGIC at **Pin G7** (**BCLKX**) and **Pin J2** (**BDX**)

7) The operation of the MAGIC is very complex and with respect to the transmit path, integrates the functions of the Modem and its function of GMSK (Gaussian Minimum Shift Keying) and also the functions of the TIC (Translational Integrated Circuit).

8) A very basic block view of how the transmit path works within the MAGIC is demonstrated in: Fig 8.1

Internal MAGIC Operation **Fig 8.1**



9) The data is transmitted from Whitecap to MAGIC on TX SPI bus **BDX**, within the MAGIC each bit of data is clocked into a register. The clocked bit and the 3 preceding bits on the register are then clocked into the look up ROM, which looks at the digital word and from that information downloads the appropriate GSMK digital representation. Channel information and AFC information from MAGIC SPI is then added to this new digital word, this word is then representative of the TX IF frequency of GIFSYN products. As in the case of the TIC, the TX frequency feedback and the RX VCO frequency are mixed to give a difference signal, this is digitally phase compared with the 'modulation' from the look up ROM. The difference creates a DC error voltage **TX_CP** that forms part of the TX Phase locked loop.

10) The error correction voltage **CP_TX** is then fed from **Pin B1** of MAGIC to **Pin 8** of the TX VCO IC U250, adjoining this line is the loop filter (See Loop Filter document on the GSM Service Support Website).

11) The Loop filter comprises mainly of U200 / Q201 / Q202 and C205 and it's main function is to 'smooth' out any overshoots when the channel is changed, see Fig 11.1. If this overshoot were fed to the TX VCO the resulting burst would not meet the world standards for GSM with respect to bandwidth, see Fig 11.2.

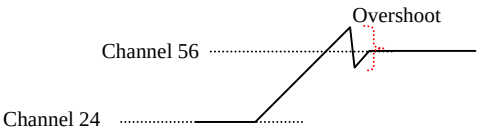


Fig 11.1

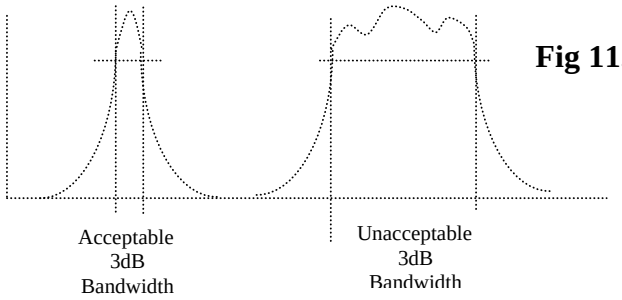


Fig 11.2

12) The Loop filter basically acts then as a huge capacitor and resistor to give a long CR time for smoothing. It uses a small capacitor and the very high input impedance buffer Op-Amp. During the **TX_EN** (Whitecap) period when the transmitter is preparing to operate the capacitor charges, then on receipt of **DM_CS** (Whitecap) when the Transmitter actually fires; the capacitor discharges through the Op-Amp giving a smooth tuning voltage, carrying modulation to the TX VCO. The support voltage for the Loop filter is **V1_FILT** (**V1** + **MAGIC Pin C2**).

13) The TX VCO IC now creates our required output frequency with the support signals **D_TX_VCO** (**DCS_SEL** (MAGIC **Pin C4**) +**TVCO_250** (Q343) through Q333) and **G_TX_VCO** (**GSM_SEL** (U201) +**TVCO_250** (Q343) through Q333), to enable either GSM or DCS frequency production and the IC Power is supported by **SF_OUT** (MAGIC).

14) The output signal is now split with a sample sent back to MAGIC to control the TX Phase locked loop

15) The remaining signal is then fed out through a pre amplifier Q455, which is supported via **PAC_275**

16) To prevent the output frequency from the TX VCO before stabilisation has occurred, being amplified and transmitted, there are Isolation Diodes CR300 (DCS) and CR301 (GSM) placed. This is biased 'on' by the exciter voltage from the PAC IC U350 (Power Amplifier Control IC); **Pin 7** this allows the TX output frequency through to the Exciter stages Q300 and Q400 respectively and at same time gives more or less drive to the exciter stage via Q301 (supported by **G_TX_VCO** and **D_TX_VCO**) The exciter stages are supported by **PA B+ (B+ and PAC_275** through Q330.

17) The signal is then fed to a two separate uni-stage, narrow bandwidth Integrated PA's made up from Q300 (DCS) and Q400 (GSM), these are driven by the exciter voltage from the PAC IC, and supported by **PA_B+.** Name changes to **DCS_PA_B+** for U400. The PA is negatively biased using **–5V_SW** and for GSM using the transistor network Q303, Q304 and Q301, for DCS using Q302, Q303 and Q301.

18) PA matching is achieved using the MCIC Filter FL300 and the signal **GSM_PINDIODE** (**-5V** and **DCS_SEL** through Q322). The signal switches in or out tuning stubs within the MCIC to provide correct matching. The MCIC filter also samples off part of the transmitted power to feed back to the PAC IC U340

19) The signal now goes through FL1000, FL1000 is a low pass filter, filtering 2nd and 3rd harmonics of GSM and DCS frequencies.

20) The amplified signal is then fed through to the RF switch U101, which again is controlled as was discussed in **Receive**, then passed to the Antenna A1/ Accessory Socket Switch J600

RF: Power Control Operation

1) The PAC IC U350 (Power Amplifier Control Integrated Circuit) controls the power control of the transmitter. Below is a list of the main signals associated with the PAC IC and their purposes.

2) The RF detector (**RF_IN Pin 2**) provides a DC level proportional to the peak RF voltage out of the power amplifier, this is taken via an inductive strip from the output of the PA Q370.

3) **DET_SW Pin 11**. This pin controls the variable gain stage connected between the RF detector and the integrator. The gain of the variable stage will be unity when **DET_SW** is low and will be 3 when **DET_SW** is high (floating).

4) **TX_KEY Pin 10**. This signal is used to 'pre-charge' the Exciter and P.A. and occurs 20µS before the start of the transmit pulse.

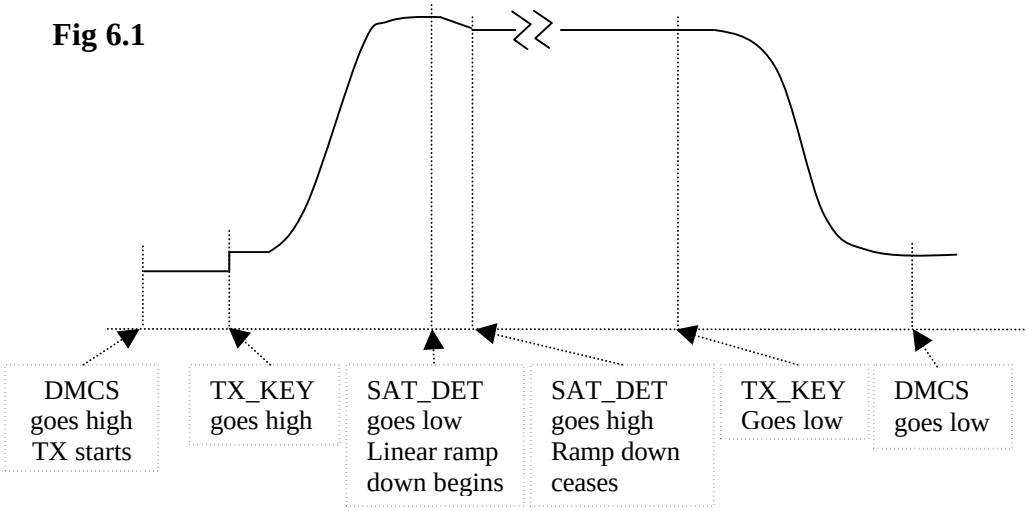
5) **EXC Pin 7**.This output drives the power control port of the exciter. An increase of this voltage will cause the exciter to increase its output power.

6) **SAT_DET Pin 12**. If the feedback signal from the RF detector lags too far behind the AOC signal then this output will go low, indicating that the loop in at or near saturation. This signals the DSP to reduce the **AOC_DRIVE** signal until **SAT_DET** rises. See **Fig 6.1**

7) **AOC_DRIVE Pin 8**. The voltage on this pin will determine the output power of the transmitter. Under normal conditions the control loop will adjust the voltage on EXC so that the power level presented to the RF detector results in equality of the voltage present at INT and AOC. The input level will be between 0 and 2.5V.

8) **ACT Pin 9**. This pin will hold a high voltage when no RF is present. Once the RF level increases enough to cause the detector to rise a few millivolts then this output will go low. In the GSM radio a resistor is routed between this point and the AOC input to cause the radio to ramp up the power until the detector goes active.

Fig 6.1


DMCS goes high TX starts
TX_KEY goes high
SAT_DET goes low Linear ramp down begins
SAT_DET goes high Ramp down ceases
TX_KEY Goes low
DMCS goes low

Logic: Power Up sequence

1) The power up sequence is very similar to Kramer with the 2 sources of power being the battery which is a slim version of the Zap battery (SNN5713A), or using an External B+ source. The unit will not operate without the battery.

2) The battery component consists of 4 output leads: serial data, ground, power supply (+) and temperature sensor.

- **BATT_SER_DATA**: J613. It connects to Whitecap Pin H5 to be used to communicate both ways with the internal EEprom on the battery. This is used to determine if the battery is authentic and what the battery charging profile is to be used. (Sometimes known as **OWDAT**)
- **Ground**: J612. It connects to be used as the reference ground
- **BATT +**: J611. It provides the main PCB with source voltage. The voltage range of A008 battery is from 1.4 VDC (after discharging) to 5.1 VDC (after charging).
- **BATT_THERM**: J610. Is used to determine the temperature of the battery. The temperature of the battery determines the end of the battery charging cycle. In order to protect the charging circuit, this line will be measured constantly during the charging period by GCAP II (U900 **Pin B3**)

  THERM: This is used to ensure that a battery is present when the phone is powered up, therefore ensuring the SIM card cannot be removed whilst the unit is powered up.

  (Q628 is used to reduce standby current)

  The A008 will use two types of charging batteries– Ni-MH battery and Li-ION battery. The unit derives its power from the battery in the following way, **BATT +** is

controlled through Battery FET Q942 by GCAP II Output **Pin F10** and is output as **B+**

2) Once **B+** is available the unit carries out the following checks:

- The battery temperature is monitored to establish whether rapid charge is required, (J610 **BATT_THERM_AD** to GCAP II **Pin B3**)
  -40 deg C – 2.75V 25 deg C – 1.39V 40 deg C – 0.96V
- Charger sensed (J600 **Pin 5** **MANTEST_AD** to GCAP II **Pin A1**) This is achieved using different sense resistors within the accessory.
  For DHFA Charger - 2.75V For Fast Charger – 2.13V
- Senses battery voltage (GCAP II **Pin F7** – **BATT+**)
- Senses input B+ level GCAP II **Pin E10** – **B+**)
  If **EXT B+** is available the current will be passed through protection diode CR940 and output as **B+** to provide power to the PCB.

3) The GCAP II is programmed to Boost mode (5.6V) by **PGM0** **Pin G7** and **PGM1** **Pin G8** both being tied to Ground. Once **B+** is applied to GCAP II **Pin K5**, all the appropriate voltages to supply the circuit are provided. These are:

- **V1** – Programmed to 5.0V. **V1** is at 2.775V at immediate power on, but is 'boosted' to 5.0V through the switch mode power supply L901 / CR901 and C934. See **Fig 6.1** for basic operation.

- **V1** supplies the DSC bus drivers, negative voltage regulators and MAGIC. **V1** is created from GCAP II **Pin A6** and can be measured on C906.

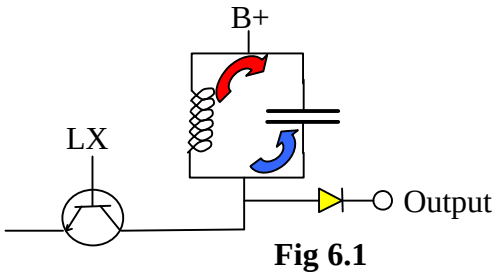


Fig 6.1

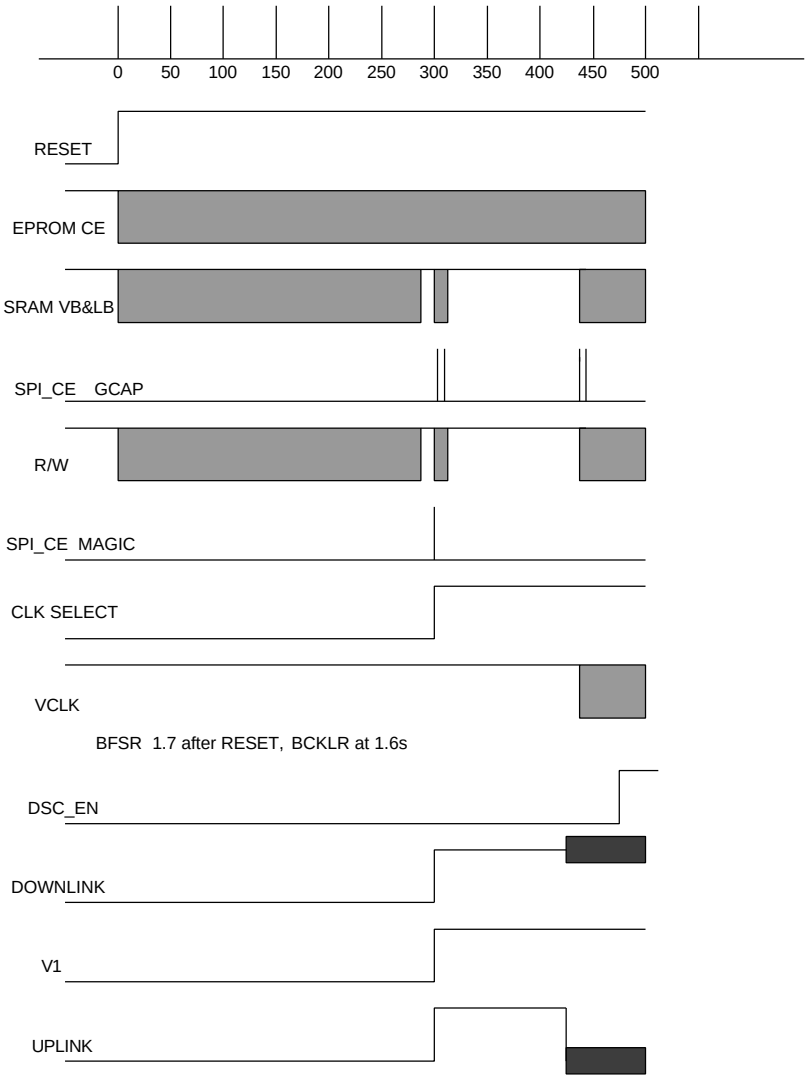
The basic circuit operation for the Boost circuit is as follows the **LX** signal (GCAP II **Pin B10**) allows a path for **B+** to charge the capacitor, when the switch is on, the capacitor then discharges through the inductor (switch off), setting up an electric field. The field then collapses setting up a back EMF to charge the capacitor, and so on and so on. The back EMF created by the inductor is greater than **B+** with the +ve half of the cycle passing through the diode to charge a capacitor from where the **V_BOOST** voltage is taken. The frequency of the switching signal **LX** decides the duty cycle of the output wave and therefore the resultant voltage. **V_BOOST** is fed back into the GCAP.
On initial power up the **LX** signal is not always immediately correct in frequency, therefore the duty cycle of the **B+** signal is incorrect which can lead to the switch mode power supply creating huge current problems. To prevent this Q9808 is placed with Q902 as a protection circuit.

As excess current is drawn through **B+** towards L901 through Q9808 source, **Pin 4**. Q902 base will go low forcing its collector high. This high on **Pin 3** Gate of Q9808 will switch off Q9808, therefore preventing **B+** to the power supply, until **LX** is stable.

- **V2** – Programmed to 2.775V, available whenever the radio is on and supplies most of the logic side of the board. **V2** is supplied out of GCAP II **Pin J2** and can be measured on either C923 or C924.
- **V3** – Programmed to 2.003V to support the Whitecap, but does support the normal 2.75V logic output from the Whitecap, it originates from GCAP II **Pin B5** and can be measured on C926 or C927.
- **VSIM1** – Used to support either 3V or 5V SIM cards. Will dynamically be set to 3V upon power up, but if the card cannot be read then the SIM card is powered down and an attempt to read the card at 5V is tried. **VSIM1** can be measured on C928 and is distributed from GCAP II **Pin C6** (For further information, see SIM Card Operation).
- **VREF** – Programmed as **V2** i.e. 2.775 and provides a reference voltage for the MAGIC IC, distributed from GCAP II **Pin G9** and can be measured on C939.
- **-5V –** Used to drive TX Biasing, produced from **LS_V1** and **–5V_EN** through U901
- **SR_VCC** – **Power Cut Circuit -** Used to buffer the SRAM U702 voltage with a built in soft reset within the unit's software. The reason for this is to protect the user from any accidental loss of power up to 0.5 seconds i.e. If the unit is knocked, causing a slight battery contact bounce, the **SR_VCC** will, to the user, keep the unit running normally, whilst internally the unit resets itself. During this loss of power the unit takes it's power from a the **RTC BATT. SR_VCC** is created from a buffered **V2** using R9922
- **V1_SW –** See **Deep Sleep Mode**

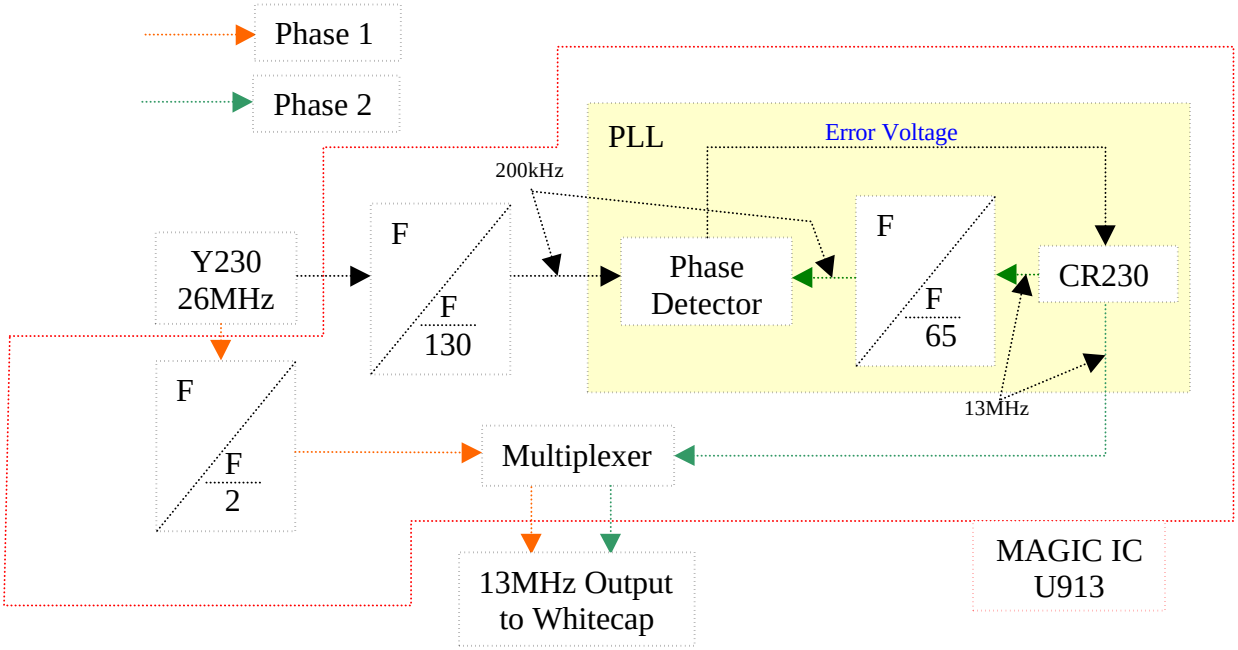
4) Once the power source has been selected to power the phone on the **PWR_SW** must be toggled low. This can be done by pressing the Power Key to create **PWR_SW**, which is supported by **ON+** (GCAP II **Pin C8**), or inserting an external power source into the Accessory Connector J600. Either way will drive **Pin G5 ON2+** low

5) The unit will then follow on as in the sequence below:



6) **13 MHz clock**. On Power Up there are 2 different reference clocks produced. Initially, as soon as power is applied to the MAGIC IC the crystal, Y200, supported by the **CRYSTAL_BASE** (MAGIC **Pin E1**) will emit a 26MHz signal to the MAGIC IC, which will internally be divided by 2 to give our external 13MHz clock. This is then fed out of the MAGIC on **Pin J6** (**CLK_OUT**) and distributed to Whitecap **Pin H10** (**CLKIN**), then from Whitecap to GCAP II **Pin F5** as **GCAP_CLK**. At the same time the 13MHz Varactor Diode CR248 is producing an output. This output is controlled in the following way: The 26MHz from Y230 is divided down to 200 kHz and fed to a phase comparator within the MAGIC. The 13MHz from CR230 is also divided down and fed in to the phase comparator, the difference in phase produces an error voltage that is fed onto the cathode of the Varactor CR230. Which regulates the output to a stable 13MHz clock. Once the software is running and the logic side of the board has successfully powered up, the **CLK_SELECT** signal from Whitecap **Pin 1** is fed to MAGIC **Pin G6**. This in turn

then switches the Multiplexer from the output of Y200 to the CR230 output. A high will switch to 13MHz.



Logic: SIM Card Interface

1) Once powered up, the SIM card is interrogated. The SIM interface is part of the Whitecap U800 and it supports both 'synchronous' (Prepay card) and asynchronous, serial data transmission, though the A008 is programmed only for asynchronous. **VSIM1** (**SIM_VCC**) is originally programmed to 3V but if the card is 5V then the SIM card will be powered down and **VSIM1** will be reprogrammed to 5V The Whitecap interprets that the card is 5V if after programming with 3V, it cannot read any data from the card. The signal levels for in and out of the SIM are now required to be level shifted within GCAP II U900 to 3V these signals are:

- **Reset** (Whitecap Pin E9 – **RST0**) in to GCAP II **Pin E9** – **LS1_IN_TG1A**. This signal is then level shifted to the required voltage and fed out to SIM Contacts J900 **Pin 4** from **Pin J7** - **LS1_OUT_TG1A**.
- **Clock**: This is a 3.25MHz signal from Whitecap – **CLK0 Pin E7** to GCAP II **Pin G6** – **LS2_IN**. This signal is then level shifted to the required voltage and fed out to SIM Contacts J900 **Pin 6** from **Pin F6** – **LS2_OUT**.
- **SIM I/O** – Data transmission to and from SIM card; for TX, from SIM card contact **SIM I/O Pin 5** through to GCAP II **Pin J8 SIM I/O**. Through level shifter to desired voltage and out through **Pin K10** (**LS3_TX_PA_B+**) to Whitecap **Pin F3 DAT0_TX**. For RX data from Whitecap **Pin B5 DATA0_RX** to GCAP II, **Pin H8** – **LS3_RX** where the signal is level shifted to desired voltage and outputted on Pin J8 **SIM I/O** to SIM contacts **Pin 5 SIM I/O**.
- **SIM_PD** – This signal is provided by the signal **THERM** (Batt Contact J610), or by **BATT+**. If there are no batteries present then the unit will display 'Insert Battery'. If batteries are present but the SIM card is either not inserted or faulty '! NO SIM CARD ' will be displayed. The reason behind this is to prevent the extra cost of a

mechanical SIM presence detect switch and to prevent the SIM card being removed whilst connected to Aux Power.

NB With no SIM card, Antenna Off can be selected and the unit can be used directly as an organiser without the use of the transceiver.

Logic: Charger Circuit

1) The charging operation is as follows:
2) After a charger has been detected **MAN_TEST_AD**, the Whitecap U700 will communicate with the device via **DSC_EN**.
3) **EXT B+** is fed in from Accessory Connector J600 **Pin 14** to the source of Q901, controlled by U9819,(these components are placed purely for high voltage protection), this voltage will then be passed back to the source of Q932, where the line **MOBPORTB** detects the presence of **EXT B+.** The current is sensed through R932 Current Sense Resistor, the voltage drop over it is sent to GCAP II **Pin D9 I_SENSE**, this is used to evaluate the charging current.
4) The charging current is then passed through CR932 to charge **BATT +**. The charge current is restricted by the signal **CHRGC** – GCAP II **Pin E8**, this opens the gate of Q635. **CHRGC** is programmed during charger phasing.
5) **CHRG_EN** Whitecap **Pin 1**, biases Q634 On or Off

Logic: Deep Sleep Mode

1) Deep sleep mode is there to provide a facility to save battery life by intermittently shutting off part of the PCB. This is achieved in the following way. The signal **STDBY** is generated from Whitecap **Pin F1**, and from here the signal is then passed onto Q960 and Q921. This has the effect respectively of:
2) Grounding **VREF** which makes MAGIC inoperable
3) Grounding **V2** This switches off MAGIC, and inhibits the Transmit path through **RF_V2**
4) Also the signal is passed through a standby delay using the logic gate U9820 and diode CR701 these provide a short delay between the de-activation of **V2** and **VREF** and the activation of **LS_V1**. Which will support the Down-link lines during sleep mode.
5) The shutdown is only for a fraction of a second and during that time the GCAP Clock supports the logic side of the unit. The GCAP clock is generated by Y900, which generates a 32.768MHz clock. This clock is output from Whitecap **Pin C7** and fed directly to Whitecap **Pin P4**. The clock is always monitored by Whitecap and should it fail, the unit will no longer go into deep sleep mode.

Logic: Keypad Operation

1) The keypad works as a matrix supported by V2. The signals inform the Whitecap upon a key press by dropping the signal 'low'. There are only 6 'hard' keys, these are:

PAGE UP – **KBR0**
PAGE DOWN – **KBR1**
HOME – **KBC0**
POWER – **PWR_SW**
VA – **KBC3**
JOG DIAL – **KBR2 / KBR3** for clockwise operation
KBC1 / GND for counter clockwise operation
KBR3 / KBR2 for push.

The jog dial can be used for most scrolling operations within the touch screen menu
HS_INT is used to detect the Flip being opened

PDA

Next to being a telephone the A6188 is a touch screen personal organiser. It incorporates many functions these being:

- Address book
- Recent call Log
- WAP Browser
- Voice recorder
- Calculator
- Currency Converter
- Measurement converter
- Instant Messaging
- Transfer Application
- Messaging Center
- Diary
- Memo pad
- Chinese / English Dictionary
- Games are available
- KJAVA
- Full Email functions
- Truesync PC ⟷ A6188 Data

Dragon Ball IC U2000

1) Dragon Ball is the processor that operates the running system of the display. The MC68EZ328 features a more flexible LCD controller with streamlined list of peripherals placed in a smaller package. This processor mainly targeted for portable consumer products, which require less peripheral and a more flexible LCD controller. By providing 3V, fully static operation in an efficient 100 TQFP package.

2) Static 68EC000 Core Processor

- 32-Bit internal address bus
- 24-Bit external address bus capable of addressing maximum 4 x 16MB blocks with chip selects 16-Bit on-chip data bus for MC68000 bus operations
- Static design allows processor clock to be stopped to provide power savings
- External M68000 Bus interface with selectable bus sizing for 8-bit and 16-bit data ports

3) System Integration Module (SIM28-EZ)

Related to External Array Logic, such as:

- System configuration, programmable address mapping
- Interface to SRAM, EPROM, FLASH memory
- 8 programmable chip selects with wait state generation logic
- 4 programmable interrupt I/O and with keyboard interrupt capability
- 5 general purpose, programmable edge/level/polarity interrupt IRQ
- Other programmable I/O, multiplexed with peripheral functions up to 47 parallel I/O
- Low-Power mode control

4) DRAM Controller

- Support 8 bit / 16 bit port DRAM
- Programmable refresh rate
- Support up to 2 banks of DRAM/EDO DRAM
- Programmable column address size

5) UART

- Support IrDA physical layer protocol up to 115.2kbps
- 8 Bytes FIFO on TX and 12 Bytes FIFO on RX

6) Serial Peripheral Interface Port

- 16 bit programmable SPI to support external peripherals
- Master mode support

7) 16-Bit General Purpose Counter / Timer

- Automatic interrupt generation
- 60-ns resolution at 16.58-MHz system clock
- Timer input/output pin

8) Real Time Clock / Sampling Timer

- Separate power supply for the RTC
- One programmable alarm
- Capable to count up to 512 days
- Sampling Timer with selectable frequency (4Hz, 8Hz, 16Hz, 32Hz, 64Hz, 256Hz, 512Hz, 1kHz). Generate interrupt for digitizer sampling, or keyboard debouncing.

9) LCD Controller

- Software programmable screen size (up to 640*512) to support single (Non-Split) monochrome/ colour STN panels
- Capable of direct driving popular LCD drivers/modules from Motorola, Sharp, Hitachi, Toshiba etc.

- Support up to 4 grey levels out of 16 palettes.
- Utilise system memory as display memory
- LCD contrast control using 8-bit PWM

10) Pulse Width Modulation (PWM) Module

- 8 bit resolution
- 5 Byte FIFO provide more flexibility on performance
- Sound and melody generation

11) Build-in Emulation Function

- Dedicated memory space for Emulator Debug Monitor with Chip Select

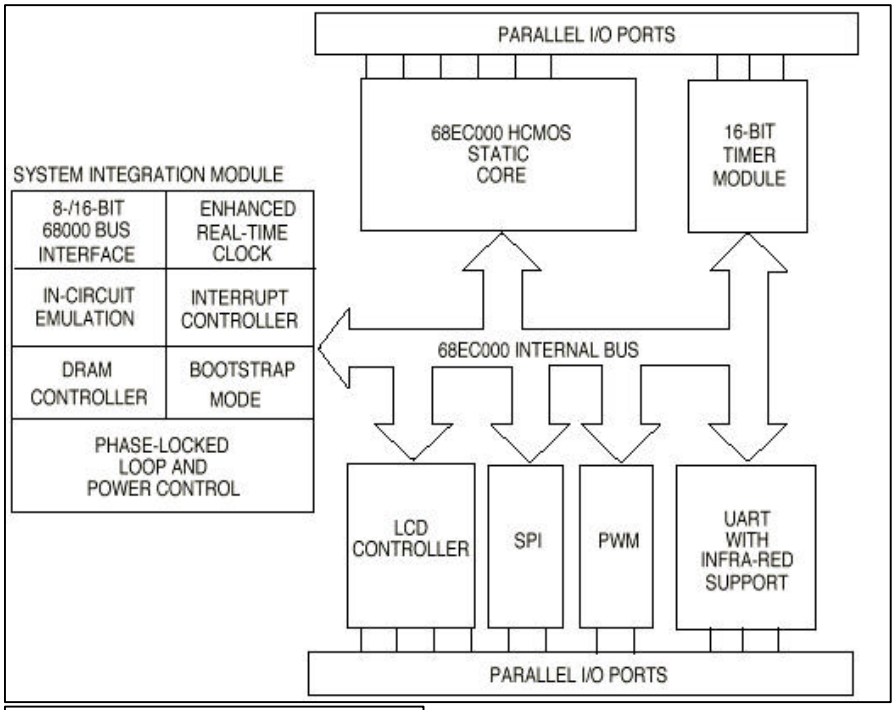
12) Boot Strap Mode Function

- Allow User to initialise system and download program/data to system memory through UART
- Accept execution command to run program stored in system memory

13) Power Management

- Fully static HCMOS technology
- Programmable clock synthesiser using 32.768 kHz/38.4 kHz crystal for full frequency control
- Low power stop capabilities
- Modules can be individually shut-down

- Operation from DC To 16.58 MHz (processor clock)
- Operating Voltage of 2.7V-3.3V
- 144 Pin Ball Grid Array (PBGA) packages



Dragon Ball Block Diagram

The touch screen is controlled in the following way See **Fig 1.**

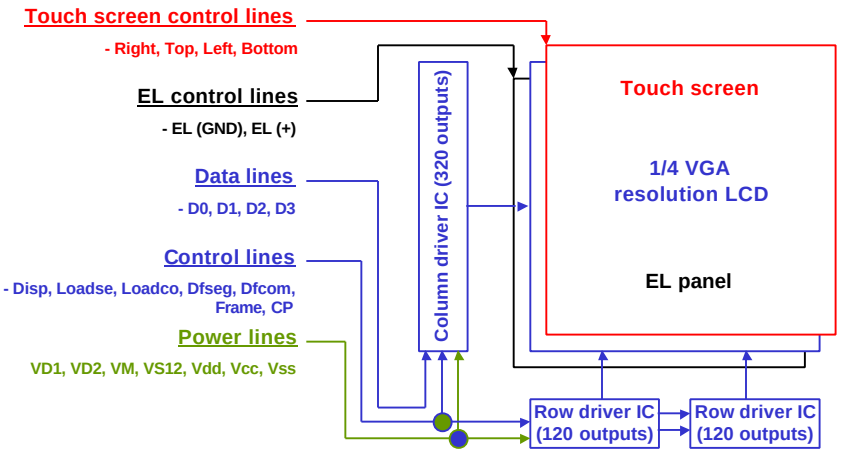

Touch screen control lines
- Right, Top, Left, Bottom
EL control lines
- EL (GND), EL (+)
Data lines
- D0, D1, D2, D3
Control lines
- Disp, Loadse, Loadco, Dfseg, Dfcom, Frame, CP
Power lines
VD1, VD2, VM, VS12, Vdd, Vcc, Vss
Column driver IC (320 outputs)
Touch screen
1/4 VGA resolution LCD
EL panel
Row driver IC (120 outputs)
Row driver IC (120 outputs)

Fig.1 LCD module electrical block diagram

Each row and column, is in effect a long imaginary resistor with a +ve voltage at one end and a –ve or Grounded voltage level at the other. We can imagine that if these resistors could be overlapped then we can create a comprehensive resistor matrix. It is this matrix that provides us with the information of where the pen is placed on the touch screen. See **Fig 2** (Example values only)

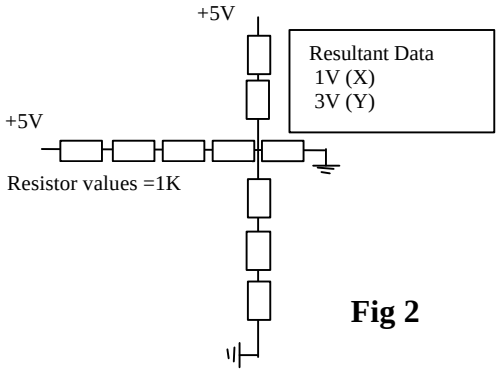


Fig 2

1) The row drivers / Control Lines **LOADCO** and **LOADCE** are originated from Dragon Ball **LLP** **Pin K8** (latches line of data J9805 where the signal becomes **LOAD_IN** before splitting to produce the 2 signals going to J9805 Pins **11** and **12**
DFSEG is originated from Dragon Ball **LACD** **PIN L7** (used to toggle the crystal polarisation) to J9805 where the signal becomes **DF_IN** changing again to **DFSEG** on J9805 **Pin 13**
LCDOFF* From Dragon Ball **Pin M2** (switches LCD On or Off – **NOT USED**)
FRAME – Used to indicate start of new frame
CP is originated from Dragon Ball **LCLK** **PIN M7** (synchronises display data) to J9805 **Pin 10**, where the signal becomes **CP**

2) Power Lines these consist of the following: These are all created in the LCD Module
VD1 – 3.3V to supply logic circuit of LCD Driver
VD2 – 3.0V to segment driver
VM – 1.5V to for comparator of segment driver
Vdd - +ve LCD Drive Voltage
Vcc – Internal Logic voltage of Com Driver IC
Vss – -ve LCD Driver Voltage

3) Contrast control is again controlled from within the LCD module using a resistive potential divider with the average room temperature contrast voltage being 12.5V.

4) The Data bus is a 4-line bus that is used to transfer pixel information to the LCD. They are **D0– D3**. These lines connect between Dragon Ball U2000 **Pins J10, M9, L9 & K9** and J9805 **Pins 6,7,8,9** respectively.

5) The EL panel within the LCD requires a LCD AC voltage to correctly orientate the liquid crystal. This is provide using a DC- AC Converter U9824. The DC to AC converter samples the DC input before separating it into small elements that will make up a sinusoidal waveform, this waveform is then stepped up to the appropriate voltage using a transformer (L9800). The input is controlled by the signal backlight and supported by **PDA_VCC** the resultant output will be a 100V amplitude sine wave, **EL+** see **Fig 3**

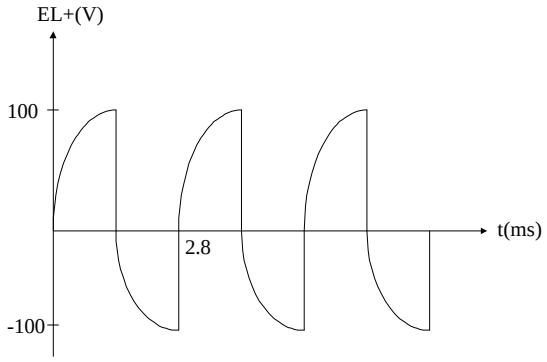
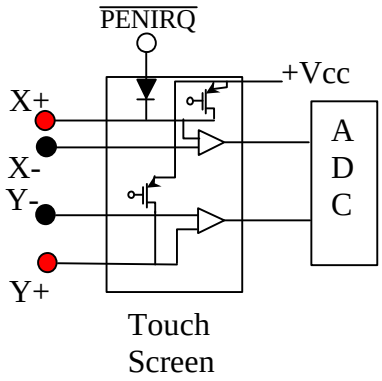


Fig 3 EL+ Driving Signal

6) This signal **EL+** is then fed to J9805 **Pin 23**

7) When the screen is touched as was discussed earlier the voltage matrix will be converted to a 12-bit word (Interrupt Request).



8) The analogue signal is fed from the LCD PCB as **RIGHT / TOP / LEFT / BOTTOM** on J9805 **Pins 1,2, 3 & 4** respectively and is fed to the ADC converter on **Pins 2, 3,4& 5.** This data is then relayed to and from Dragon Ball on **SPM_TXD** and **SPM_RXD.** The ADC is supported by **PDA_VCC.**

Logic: Communication

1) There are several ways by which the A008 can transmit and receive data; these are as follows.
   - Communication between the Whitecap and the Dragon ball, is carried on 6 lines, these are **U_CTS / U_RTX / URXD / UTXD / WD_INT* & DW_INT***.
   - When W/CAP need to send data to Dragon ball, it will send an interrupt signal to Dragon ball through **WD_INT*.** Dragon ball will response by clear **U_CTS**, then data will be send to Dragon ball over the UART port. If Dragon ball need to send data to W/CAP, it will send an interrupt to W/CAP through **DW_INT*.** The communication is the same.

2) Communication between Whitecap and GCAP uses the following lines of communication **– DR2 / DX2 / MQSPI_CLK2 / MQSPI – CS0**
   - Where **DR2** is data transfer from GCAP to Whitecap
   - Where **DX2** is data transfer from Whitecap to GCAP
   - **MQSPI_CLK2** is the data transfer clock
   - **MQSPI_CS0** is the select line for **DR2 / DX2**

3) For programming i.e. flashing the phone, we use the flow matrix consisting of U9821 / U9822 and U2601. Basic function being.
   - U9822 and U9821 are inverter and non inverting devices respectively
   - **PB2** (Whitecap **Pin L2**) is sent to the input of U9822 and also output as **A** to U9821is used to decide whether information is sent from External Connector to Whitecap or to Dragon Ball
   - The signals **CTS2*** and **RTS2*** (Dragon Ball **Pins F4 and F3**) control data flow and data can either be sent from either processor to External connector on the

UPLINK / GCAP UPLINK lines or for example Flash Information can be programmed into either Processor using **DOWNLINK / GCAP_DOWNLINK**.

4) IrDA – The IrDA transceiver module is U9812. The IrDA data takes the form of an SIP (Serial Infrared Pulse) with **SD_IrDA** being an active high signal that turns the LED on. The received signal **IrDA RXD** is always a pulsed, active low 2.4µs pulse, and a low will light the LED. The data for TX is sent to **IRDA_TXD** U9812 **Pin 7** from Dragon Ball as **TXD2** **Pin E4**. For **IRDA_RXD**, information received is passed from U9812 to Dragon Ball as **RXD2** **Pin E3**